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**The Structure of Perceptual Justification**

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**The Structure of Perceptual Justification**

**by**

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Dedicated to Julie and Neva.

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A beginning graduate student asked me which faculty members I find to be especially helpful to work with. After answering I realized that I'd just named the members of my dissertation committee: David Sosa, Josh Dever, Sinan Dogramaci, Jim Pryor, Mark Sainsbury, and Miriam Schoenfield. I thank you all for your insights, your encouragement, and your patience.

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**The Structure of Perceptual Justification**

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When does a perceptual experience as of my hands provide justification for me to believe that I have hands? One initially plausible *positive* requirement is that I must have reasons to believe something else: that my experience is veridical. Also plausible is the *negative* requirement that I must not have reasons to believe that my experience is in this case non-veridical. Dogmatists about perception reject the positive requirement and embrace the negative one, holding that perceptual justification is *immediate* — it doesn't rest upon any other justification that I possess — but it is also defeasible, and in particular it is *underminable.*

Whereas Dogmatism is a theory in the epistemology of perception, Bayesianism is a theory of coherence for partial beliefs and of how coherence it to be maintained in the face of new evidence. Just as it is incoherent to believe both *I have hands* and ¬*(I have hands)*, it is incoherent to be highly

confident in both of those propositions. Bayesianism offers a formal account of this latter type of coherence. Importantly, though Bayesianism is a *theory of coherence*, it is not a *coherence theory* of the sort defended by Davidson and BonJour: it is not an attempt to explain all facts about justification in terms of facts about coherence. Hence the Bayesian's claim that partial beliefs are subject to norms of coherence is at least prima facie consistent with the Dogmatist's claim that some beliefs are immediately justified by experience.

I develop and defend Bayesian Dogmatism. I begin by responding to an argument advanced by Cohen, Hawthorne, Schiffer, and White, which purports to show that Bayesians cannot model episodes of perceptual learning in which the proposition learned is both immediately justified and defeasible. I go on to respond to arguments from Weisberg, which purport to show that Bayesianism is inconsistent with underminable perceptual learning. Finally, I defend the superiority of Jeffrey Conditionalization to Holistic Conditionalization as a rule of updating on propositions learned from experience.

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# Chapter 1

# How to be a Bayesian Dogmatist[1]

## 1.1 Introduction

I'm walking down the street and I have a visual experience as of a red ball lying on the grass. What's the epistemic significance of my having had that experience? One likely result is that I obtain some justification for a belief about my own experiences, something like *I've had an experience as if there's a red ball lying on the grass.* Another is that I obtain some justification for a belief about the world, something *like there's a red ball lying on the grass.* Yet another is that I now find myself with justification to believe further propositions inferentially related to the first two: if I already had justification to believe that there's a bike on the grass and then I have my perceptual experience as of the ball, I obtain some justification for believing *there are at least two toys on the grass.* My justification for the last of these three propositions is unambiguously mediate, as it's at least in part my justification for believing something else that makes me justified in believing that there are at least two toys on the grass. In contrast, my justification for believing I've had an experience as if there's a red ball lying on the grass comes

[1]For a published version of his chapter see: Brian T. Miller. How to be a Bayesian Dogmatist. *Australasian Journal of Philosophy*, forthcoming.

directly from the experience itself without the mediation of some other justification that I have, and hence that justification is immediate. That much is common ground between *Inferentialist* and *Dogmatist* accounts of perceptual justification. What's contentious between the two is the status of the second proposition.

According to the Dogmatist, perceptual justification is both immediate[2] and underminable[3] (see Pryor [2000], [2005], [2013]). Moreover, the Dogmatist thinks that while a perceptual experience may generate immediate and underminable justification for *I'm having an experience as if* $A$ or some other proposition about the agent's mental states, it also generates immediate and underminable justification for $A$ itself.

In contrast, the Inferentialist claims that my beliefs about the external world are never immediately justified (at least not on the basis of experience), but rather depend upon an inference from an immediately justified proposition about my own experiences together with an auxiliary proposition connecting facts about my experiences to facts about the external world, e.g. *If I have a perceptual experience as if* $A$ *then, probably,* $A$. Hence it's my justification

[2]My justification for believing that $A$ is *immediate* unless it is in part my having justification to believe something else that *makes me* justified in believing that $A$. 'Makes' here expresses a relation of epistemic dependence, a variety of modal dependence. Hence Dogmatism shouldn't be confused with the much stronger thesis that having a perceptual experience in the absence of defeaters is *sufficient* for obtaining perceptual justification, as we allow that there might be other necessary conditions for obtaining perceptual justification besides my having justification to believe something else, as long as the satisfaction of that condition is not part of what makes me justified.

[3]For the distinction between undermining/ undercutting and opposing/ rebutting defeaters see [Pollock and Cruz, 1999, 196-7].

for believing *I've had an experience as if there's a red ball lying on the grass* together with my justification for believing some such auxiliary proposition that makes it the case that I have justification for believing *there's a red ball lying on the grass*, and so that last bit of justification is mediate.

Dogmatism makes obtaining perceptual justification relatively easy: any agent capable of having a contentful experience and lacking defeaters is in a position to obtain justification for lots of beliefs about the world without first acquiring justification for beliefs about the relationship between experience and the external world. Whether this is ultimately a virtue of the theory or a shortcoming is contentious: easily acquired justification for propositions about the external world might be thought to license too-easy responses to skeptical challenges to our knowledge of the external world and too-easy knowledge of the reliability of our perceptual faculties. If Inferentialism is correct then obtaining perceptual justification is in some sense harder, as we first need justification to believe the auxiliary proposition connecting the having of an experience with facts about the world. Making it harder to obtain perceptual justification comes with its own set of problems, as now we're faced with the difficult task of explaining where justification for believing the auxiliary propositions comes from, potentially leaving skeptical problems insoluble.

In this essay I defend Dogmatism against a very different objection: that it is inconsistent with Bayesianism. The Bayesian Argument (as I'll call it) purports to show that given Bayesianism, acquiring perceptual justification for believing *there's a red ball lying on the grass* requires that I already have justification for ruling out a wide range of skeptical scenarios on which my experience as of the ball lying on the grass is non-veridical. If obtaining perceptual justification for believing that $B$ requires that I already have justification for believing that $A$, then (the objection goes) it's plausible that my justification for $A$ is what makes me justified in believing $B$, in which case my justification for believing that $B$ isn't immediate. Since this result allegedly follows from the Bayesian formalism, we thereby have some reason to believe that Dogmatism and Bayesianism are inconsistent, and since Bayesianism is an attractive theory we thereby have a reason to reject Dogmatism.

The literature contains two types of response to this argument on behalf of the Dogmatist. The first response is to accept the inconsistency of Dogmatism and Bayesianism and take that as a good reason to revise orthodox Bayesianism (see Weatherson [2007]). The second and seemingly more common response is to accept the formal result — that a necessary condition for obtaining justification for believing the content of perceptual experience is having antecedent justification for believing some other proposition — but then to deny that it entails the mediacy of perceptual justification. One way to do this would be to take inspiration from Silins [2007] and argue that having justification to believe that $A$ might be a necessary condition for obtaining justification for believing that $B$ without $A$ being what makes it the case that I have that justification for believing that $B$. Mere modal dependence just isn't what matters when it comes to questions of immediacy, and hence my justification for believing that $B$ might nonetheless be immediate.[4]

I pursue a third response to the Bayesian Argument on behalf of the Dogmatist: I deny that the putatively problematic formal result is a commitment of the Bayesian at all. The derivation of that result requires a premise that goes beyond the core commitments of Bayesianism to specify precisely how the epistemic significance of experience should be reflected in the formal model. This requires that I be clear about exactly what the Bayesian is and is not committed to, an issue that I discuss in section 1.2. In section 1.3 I lay out the formal details of the Bayesian Argument. The heart of the paper is found in section 1.4, in which I identify the problematic premise and argue both that it is optional for the Bayesian and that it is prejudicial against the Dogmatist. I then offer an alternative account of how the epistemic impact of experience should be incorporated into Bayesian models. In section 1.5 I consider the implications of adopting my suggestion for various versions of Bayesianism, concluding that the Dogmatist should embrace a version that incorporates Richard Jeffrey's permissive approach to conditionalization over the strict approach of the Classical Bayesian.

[4]A second way to accept the formal result of the Bayesian Argument without abandoning Dogmatism exploits the fact that Dogmatism is discussed in the idiom of reasons while Bayesianism is discussed in the idiom of credences. Translating between the two idioms is not entirely straightforward. In particular, it's not obvious that obtaining a reason to believe that $A$ always leads to an increased credence $A$. See Kung [2010] and Zardini [2014].

## 1.2 Bayesianism

Bayesianism is a theory of the rationality of partial belief states. The starting assumption is that an agent's partial beliefs can be represented as a function from propositions to numbers representing that agent's subjective probability or credence that various propositions are true. The core of Bayesianism is the postulation of two necessary conditions on the rationality of a credence. The first is Probabilism:

**Probabilism:** all rationally permissible credence functions are probabilistically coherent (i.e. consistent with the probability axioms).

Probabilism imposes a synchronic constraint upon rational credence functions. Constraining the rationality of revisions to those credence functions over time is the thesis of Conditionalization. Conditionalization requires that we divide our credences into two types: conditional and unconditional. Whereas unconditional credences reflect an agent's degree of confidence in the truth of a proposition considered on its own, conditional credences reflect the agent's confidence in a proposition given the truth of some other proposition. For example, the agent might assign a low unconditional credence to *the street is wet* but a much higher credence to it given *it's raining*: formally, $P(\textit{the street is wet}) < P(\textit{the street is wet} \mid \textit{it's raining})$. The intuition motivating Conditionalization is that the credences that an agent should adopt in the future upon obtaining new information are importantly constrained by the conditional credences that he or she holds right now, and that those constraints are encoded in the agent's currently held conditional credences. I'll be discussing two ways of making this intuition rigorous. First:

**Strict Conditionalization:** If I revise my credence in $B$ to 1 then I must set my new credence in $A$ equal to my old credence in $A$ conditional on $B$: $P_{new}(A) = P_{old}(A \mid B)$

It is important to note that according to Strict Conditionalization, incorporating new information $B$ by conditionalizing upon it requires changing $P(B)$ to 1.[5] Jeffrey Conditionalization generalizes Strict Conditionalization by allowing updates upon changes in credences to values other than 1:

**Jeffrey Conditionalization:** If I revise my credence in $B$ to any value then I must set my new credence in $A$ equal to the weighted sum of $A$ conditional on $B$ and $A$ conditional on $B$:[6] $P_{old}(A \mid B)P_{new}(B) + P_{old}(A \mid \neg B)P_{new}(\neg B)$

For our purposes Classical Bayesianism is the combination of Probabilism and Strict Conditionalization and Jeffrey Bayesianism is the combination

[5]For reasons that I discuss in section 1.4.1, especially fn. 13, I'll assume throughout the essay that proponents of Strict Conditionalization will prohibit 'exogenous' credence revisions (again, see section 1.4.1) to values less than 1.

[6]See [Jeffrey, 1983, 169]. Jeffrey goes on to generalize this condition to accommodate changes to the partition involving more than two propositions, a complication inessential to the present essay.

of Probabilism and Jeffrey Conditionalization. Since my task in this essay is to show the Bayesian Argument exposes no great tension between Dogmatism and either version of Bayesianism, I will proceed to show that the argument exposes no great tension between Dogmatism and the combination of Probabilism and either version of Conditionalization (though later on I settle on Jeffrey Bayesianism as the better complement to Dogmatism).

## 1.3 The Bayesian Argument Against Dogmatism

For the Dogmatist, possessing an undermining defeater blocks the acquisition of perceptual justification, but lacking justification to reject an undermining defeater is perfectly consistent with the acquisition of perceptual justification. To illustrate, consider *BIV*, the hypothesis that I'm a handless brain in a vat having experiences as of my hands (i.e. the sorts of experiences that we expect to have when we look down past the ends of our wrists). Dogmatists hold that if I have high levels of justification for believing that *BIV* is true then my experience as of my hands will fail to generate much justification for the proposition *I have hands*, as the justificatory force of the experience is undermined. But Dogmatists also hold that I don't need justification for believing that *BIV* is false in order to acquire justification for *I have hands* from my experience. It's this last point that is the target of the Bayesian Argument.

*BIV* is the hypothesis that I'm a handless brain in a vat having experiences as of my hands, and so *BIV* implies that I'm having an experience as of my hands. Taking $e$ as the proposition *I'm having an experience as if I have hands*, that means:[7]

(1) $P_{old}(\neg BIV \mid e) \leq P_{old}(\neg BIV)$

When I have an experience as of my hands I thereby obtain some justification for believing that I'm having an experience as of my hands. According to Conditionalization I must now update upon that changed credence in $e$,[8] and so:[9]

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[7]Proof: $BIV \vDash e$, so $P(e \mid BIV) = 1 \geq P(e)$, so $P(BIV \mid e) \geq P(BIV)$ (by Bayes's Theorem), so $P(\neg BIV \mid e) \leq P(\neg BIV)$.

[8]While this is correct as far as it goes — Conditionalization does indeed require that we update upon changes to the probabilities that we assign to propositions like $e$ — I will argue in section 1.4 that updating upon $e$ alone is both unwarranted and key to the argument. Nonetheless at this point I'll suppose that it is correct in order to present my opponent's argument.

[9]In particular, (2) is meant to follow from *Strict* Conditionalization (plus the description of the case). The argument is slightly different when Jeffrey Conditionalization is employed, as (2) now becomes:

$$P_{new}(\neg BIV) = P_{old}(\neg BIV \mid e)P_{new}(e) + P_{old}(\neg BIV \mid \neg e)P_{new}(\neg e)$$

As I note in section 1.4.3, for our purposes $BIV$ is equivalent to the hypothesis that $e\&\neg h$, and so this is equivalent to:

$$P_{new}(\neg(e\&\neg h)) = P_{old}(\neg(e\&\neg h) \mid e)P_{new}(e) + P_{old}(\neg(e\&\neg h) \mid \neg e)P_{new}(\neg e)$$

Equivalently:

$$P_{new}(\neg e \vee h) = P_{old}(\neg e \vee h \mid e)P_{new}(e) + P_{old}(\neg e \vee h \mid \neg e)P_{new}(\neg e)$$

Which simplifies to:

$$P_{new}(\neg e \vee h) = P_{old}(h \mid e)P_{new}(e) + 1(P_{new}(\neg e))$$

$e\&\neg h$ is at least possible, and so $P_{old}(h \mid e) < 1$. As a result, the higher the value of $P_{new}(e)$ the lower the value of $P_{new}(\neg e \vee h)$. This is most easily seen by first considering the case in which $P_{new}(e) = 0$. In that case $P_{new}(\neg e) = 1$, and so $P_{new}(\neg e \vee h) = (P_{old}(h \mid e))0 + 1(1) = 1$. As $P_{new}(\neg e)$ decreases, $P_{new}(e)$ increases, which in this case means that

(2) $P_{new}(\neg BIV) = P_{old}(\neg BIV \mid e)$

Combining terms from (1) and (2) we get:

(3) $P_{new}(\neg BIV) \leq P_{old}(\neg BIV)$

$BIV$ is the hypothesis that I'm a handless brain in a vat having an experience as of my hands. If I have hands then I'm not a handless brain in a vat having an experience as of my hands, and so in that case $BIV$ is false. Taking $h$ as the proposition *I have hands*, it follows that:

(4) $P_{new}(h) \leq P_{new}(\neg BIV)$

Finally, (3) and (4) imply:

(5) $P_{new}(h) \leq P_{old}(\neg BIV)$

What (5) says is that my credence in $\neg BIV$ before I had the experience as of my hands must be at least as high as my posterior credence in *I have hands*,

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as $1(P_{new}(\neg e))$ decreases, $P_{old}(h \mid e)P_{new}(e)$ increases. Importantly, however, the changes aren't proportional: since $P_{old}(h \mid e) < 1$, when the value of $P_{new}(e)$ increases then the increase in $P_{old}(h \mid e)P_{new}(e)$ is smaller than the decrease in $1(P_{new}(\neg e))$. Hence if $P_{new}(\cdot)$ is the credence that I ought to adopt upon increasing my confidence in $e$ (and nothing else) and updating accordingly, then $P_{new}(\neg e \vee h) < P_{old}(\neg e \vee h)$. $h \vDash \neg e \vee h$, and so $P_{new}(h) \leq P_{new}(\neg e \vee h)$. Put this all together and we get:

$$P_{new}(h) \leq P_{new}(\neg e \vee h)) < P_{old}(\neg e \vee h))$$

In plain English, if $P_{new}$ is the credence function that I adopt as a result of increasing my confidence in $e$ (and nothing else) and updating accordingly, then my new credence in $h$ must actually be lower than my old credence in $\neg e \vee h$, i.e. in $\neg BIV$.

the credence that I adopt after having an experience as of my hands and conditionalizing. Since the Dogmatist thinks that after having an experience as of my hands my credence in the proposition *I have hands* is very high, that means that my prior credence in $\neg BIV$ must have been very high as well. That's tantamount to saying that assigning a high credence to $\neg BIV$ is a necessary condition for assigning a high credence to *I have hands* on the basis of my perceptual experiences, which (it is claimed) is inconsistent with the hypothesis that my perceptual justification for *I have hands* is immediate.[10] Analogous arguments show that no perceptual justification is immediate, and so Dogmatism is false.

## 1.4 Modeling Experience

The Bayesian Argument is valid. (1) and (4) follow from Probabilism, the Ratio Analysis of conditional probability (see section 1.5), and the logical relations that obtain between $BIV$, $h$, and $e$. (3) is a consequence of (1) and (2). But what about (2), that $P_{new}(\neg BIV) = P_{old}(\neg BIV \mid e)$? Rejecting any other step in the argument requires giving up on Probabilism (and hence giving up on Bayesianism itself), but not so with (2). If (2) is false then the

[10] That the existence of such a necessary condition is inconsistent with the immediacy of perceptual justification is far from obvious, as I discussed in fn. 2. However, if we rely on that point to respond to the Bayesian Argument we are essentially denying that (5) is problematic without disputing its truth, and hence we must still concede that obtaining perceptual justification requires that we already have justification for assigning low credences to the relevant skeptical hypotheses. I find that implausible, and so in what follows I offer a response that allows the rejection of (5) without requiring the rejection of Bayesianism itself.

argument for (5) is unsound, and so the putative tension between Dogmatism and Bayesianism is resolved.

But how can we reject (2) without rejecting Conditionalization? Note that there are two importantly different ways of thinking about credence function $P_{new}(\cdot)$ and so two importantly different ways of thinking about (2). $P_{new}(\cdot)$ might be understood simply as the credence function resulting from having $P_{old}(\cdot)$ and then updating on e, and in that case (2) is a trivial consequence of Conditionalization. Alternately, $P_{new}(\cdot)$ might be understood only as the credence function that an agent who holds $P_{old}(\cdot)$ ought to adopt after having an experience as of his hands and updating accordingly, whatever that function happens to be.

This is important because in order to avoid equivocation, $P_{new}(\cdot)$ must be interpreted the same at (2) and at (5). If $P_{new}(\cdot)$ is interpreted in the first of these two ways, then all (5) says is that updating on $e$ (and $e$ alone) can't raise $P_{new}(h)$ any higher than $P_{old}(\neg BIV)$. But Dogmatism isn't a theory of how an agent with $P_{old}(\cdot)$ who updates on $e$ ought to revise his beliefs; it's a theory of how an agent with $P_{old}(\cdot)$ who has an experience as if he has hands ought to revise his beliefs. Hence in order for (5) to pose a challenge to Dogmatism, $P_{new}(\cdot)$ must be understood as the credence function that an agent who holds $P_{old}(\cdot)$ ought to adopt after having an experience as of his hands and updating accordingly.

The two interpretations of $P_{new}(\cdot)$ aren't necessarily inconsistent: it may be that the credence function that an agent ought to adopt upon having an experience as if $h$ just is the one that results from updating on $e$ and $e$ alone, and in that case the two interpretations are equivalent. But that's a substantive assumption, and as I argue below the Dogmatist has independent reasons to reject it. After all, Dogmatists think that my experience as if $h$ provides immediate justification not just for $e$, but for $h$ as well. In that case it's just false that $P_{new}(\cdot) = P_{old}(\cdot \mid e)$, and so the interpretation of $P_{new}(\cdot)$ on which (2) is a trivial consequence of Conditionalization is distinct from the interpretation that makes (5) problematic for Dogmatism.

My proposal, then, is that instead of (or in addition to) updating on $e$ = *I'm having an experience as if I have hands* Bayesian Dogmatists should update on $h$ = *I have hands.* This is consistent with both Classical and Jeffrey Bayesianism (see section 1.4.1), though for independent reasons its combination with Classical Bayesianism is unappealing to the Dogmatist. Indeed, I will later argue that adopting Jeffrey Bayesianism, together with the thought that it is upon $h$ that we should update (and not merely upon $e$), not only allows the Dogmatist to avoid (5), but also provides a very natural way for the Dogmatist to model perceptual learning in a Bayesian framework.[11]

[11] Compare [Pryor, 2013, sec. 6]. Since I completed this essay, a somewhat similar approach has appeared in Moretti [2015]. Our responses to the issue are, nevertheless, importantly different. According to Moretti, a basic problem with White's argument (i.e. the Bayesian Argument) is that it requires updating on a belief rather than on an experience — it 'presuppose[s] a notion of perceptual evidence that is not the one distinctive of dogmatism' [271]. But all Bayesian models share that requirement — you can't conditionalize on an experience! — and hence if White's presupposition is inconsistent with Dogmatism then Bayesianism is inconsistent with Dogmatism too. This rests on a mistake: what's required is simply that we allow experiences to spark credence revisions that are exogenous to the model (see section 1.4.1 below); without some such allowance it's hard to see how

### 1.4.1 Bayesianism Does Not Entail (2)

I begin by showing that updating on $h$ and hence rejecting (2) is perfectly consistent with Bayesianism. My comments in this section will apply equally to both the Jeffrey and the Classical versions of Bayesianism except where I specify otherwise.

I described in section 1.2 how Bayesians construct formal models of agents' partial belief states and of revisions to those states over time. It's important to note that these are at best *partial* models of rational credence revision. Given Conditionalization, a prior credence function plus a revised credence in some proposition completely determine the posterior credence function that must be adopted: if I revise my credence in $B$ to 1, then the model determines that I should revise my credence in $A$ to my prior credence in: $A$ conditional on $B$. What the model does not determine is the rational status of my initial revision to my credence in $B$.

What does determine the rational status of the credence revisions that spark conditionalization? Clearly these can't all be the result of other conditionalizations, as the process of conditionalization only gets going with a change in credence and ends as soon as the new credence function is adopted. Hence if there are to be any rationally permitted credence revisions at all there must be some that do not proceed by conditionalization. At least some

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the epistemic significance of experience could ever make it into a Bayesian model.

On my view, White's argument is unsound not because he updates on a proposition, but because he updates on the wrong proposition.

credence revisions are rational, and hence any plausible version of Bayesianism must accept the permissibility of at least some credence revisions that don't proceed via conditionalization. All of the credence revisions that are modeled by the Bayesian formalism are conditionalizations, so it follows that some rationally permissible credence revisions are not modeled. Call those credence revisions that are not modeled by the Bayesian *exogenous* revisions (as in *exogenous to the model*) and those occurring within the model via conditionalization *endogenous* revisions.

Two points about exogenous credence revisions are worth emphasizing. First, the rational permissibility of an exogenous revision is largely unconstrained by the Bayesian machinery. Probabilism prohibits the adoption of any probabilistically incoherent credence and so it prohibits exogenous revisions that are themselves probabilistically incoherent. For example, I cannot revise my credence in $A \& \neg A$ to any value other than 0. Jeffrey Conditionalization imposes no additional constraints upon the appropriateness of the exogenous inputs: its sole function is to determine the appropriate response to a given revision. Hence any exogenous credence revision is consistent with Probabilism and Jeffrey Conditionalization as long is it is probabilistically coherent with itself.[12]

Things are a bit more complicated with Strict Conditionalization, on which updating is permitted only on propositions assigned a credence of 1.

[12] Assuming that the credence was between 0 and 1 before the revision.

Exogenous credence revisions that don't lead to updating can result in an incoherent posterior credence function,[13] so there's good reason for the Classical Bayesian to prohibit exogenous revisions that cannot be updated upon, i.e. to prohibit exogenous revisions to credences other that 1. Nonetheless, any exogenous credence revision is consistent with Classical Bayesianism as long as (i) it is probabilistically coherent with itself and (ii) the credence of the proposition being exogenously revised is thereby raised all the way to 1.[14]

The second point is that the process of incorporating the epistemic impact of having had a perceptual experience *must* begin with an exogenous credence revision. Suppose that that's false, and the credence revisions that result from having a perceptual experience are entirely endogenous and so proceed by conditionalization. As we've seen, conditionalization results from a change in credence or subjective probability: I update on *it's raining* not when it's actually true that it's raining but when my credence or subjective probability in *it's raining* changes. All instances of conditionalization begin with a change in credence and end with a change in credence. In contrast, when I revise my credences in response to a perceptual experience, the process begins with something that isn't a change in credence — the actual having of the experience — and ends with a change in credence. Hence the initial

[13]If my credence function started out coherent and I exogenously revise my credence in a single proposition then the resulting function will be incoherent. For example, if $P_{old}(A) = 7/10$ and $P_{old}(\cdot)$ is coherent, then $P_{old}(\neg A) = 3/10$. If I exogenously revise my credence in $A$ so that $P_{new}(A) = 1$ without updating, then $P_{new}(A) = 3/10$. Since $A$ and $\neg A$ are inconsistent, $P_{new}(A \vee \neg A) = P_{new}(A) + P_{new}(\neg A)$, which in this case is $13/10$.

[14]Again assuming that the credence in that proposition was between 0 and 1 before the revision.

credence revision coming in response to perceptual experience can't proceed via conditionalization and hence can't be endogenous to the Bayesian machinery.

With these points in mind I return to (2), that upon having an experience as of my hand I must set $P_{new}(\neg BIV)$ equal to $P_{old}(\neg BIV \mid e)$. It's now clear that adopting $P_{new}(\cdot)$ required two credence revisions: an exogenous revision in response to the experience, and an endogenous revision resulting from conditionalizing upon that exogenously revised credence. It's also clear that the Bayesian machinery constrains the endogenous revision but for the most part does not constrain the exogenous one, and that neither Probabilism nor Conditionalization require that the exogenous revision be on *I'm having an experience as if I have hands* rather than on *I have hands* or on some other proposition.

If we suppose that it's my credence in $e$ (and $e$ alone) that I revise in light of my experience then Bayesianism ensures the truth of (2), but Bayesianism is simply silent about whether updating my credence in $e$ is the right way to respond to my experience. Hence Bayesianism is silent concerning whether the credence function that I ought to adopt in light of having my experience, $P_{new}(\cdot)$ is equal to $P_{old}(\cdot \mid e)$. So the rejection of (2) is consistent with Bayesianism.

### 1.4.2 Dogmatists should update on h

Dogmatists claim that perceptual experience can generate immediate justification, but they also go further and specify precisely which proposition is immediately justified by an experience: the proposition constituting the content of that experience. So for the Dogmatist, a perceptual experience as of $A$ typically generates immediate justification for believing $A$. Inferentialists deny that my justification for believing $A$ is immediate, but that doesn't commit them to saying that no proposition is immediately justified by the experience. The Inferentialist thinks that obtaining justification for believing the content $A$ of a perceptual experience requires justification for believing I'm having an experience as if $A$, and also justification for believing some auxiliary proposition such as *If I've had an experience as if A then, probably, A*. Though on that picture my justification for believing that $A$ can't be immediate, presumably my justification for believing that I'm having an experience as of $A$ is immediate. Hence the Dogmatist and the Inferentialist agree that my perceptual experience as of $A$ generates at least some immediate justification, they just disagree about *which* proposition it immediately justifies.

How is this talk of immediate justification to be translated into the Bayesian idiom of credences? One thought is that my obtaining immediate justification for believing that $A$ is tantamount to rationally increasing my credence in $A$ without conditionalizing on something else in order to do so.[15] In other words, obtaining immediate justification for believing that $A$ just is exogenously revising your credence upward in $A$ in a rational way. Since the Dogmatist thinks that upon having an experience as of $A$ I become immediately justified in believing that $A$, there's a strong prima facie case that a

[15]See Pryor's 'Assumption 2' [2013, 105].

Bayesian Dogmatist should think that upon having that experience I should exogenously raise my credence in $A$ and then update upon it. Similarly, since the Inferentialist thinks that upon having an experience as of $A$ I become immediately justified in believing that *I'm having an experience as of* $A$, a Bayesian Inferentialist should think that upon having that experience I should exogenously raise my confidence in *I'm having an experience as of* $A$ and then update upon it.

As I've noted, (2) is not neutral concerning what we update upon: it requires that I update on *facts about* my experience rather than the *content* of my experience. But that requirement begs the question against the Dogmatist, who should reject it even without the putative problem that the Bayesian Argument brings to light.

Before moving on I'd like to briefly sketch an objection raised by Roger White in his [2006, 534-5]. According to White, even if having an experience as of my hands provides immediate justification for believing $h =$ *I have hands*, it no doubt *also* provides immediate justification for believing *I'm having an experience as if I have hands*, and hence I should also exogenously raise my credence in $e$. In that case Conditionalization requires that I update upon $e$, and so what does it matter if we also conditionalize on $h$? Won't updating on $e$ raise my confidence in $BIV$, and hence even further limit my confidence in $h$? And in that case isn't the Dogmatist still stuck with the problematic conclusion at (5) after all?

No. The success of the Bayesian Argument does not depend on whether we update on $e$, but on whether we update on $h$. Allowing exogenous revisions to $h$ means that my prior credence in $BIV$ no longer limits my posterior credence in $h$, and hence the putatively problematic (5) is false. To see this point, however, it's helpful to first appreciate exactly how updating on $h$ solves the problem, and so I put off my full response to White's objection until the end of the next section.

### 1.4.3 How updating on $h$ resolves the problem

Intuitively, the problem with learning that $h$ by updating on $e$ is that my posterior credence in $h$ is limited by my prior credence in $\neg BIV$, and so if updating on $e$ allows me to become highly confident in $h$ then I must have started out highly confident in $\neg BIV$. In other words, when I update on $e$, my prior credence in $\neg BIV$ caps my posterior credence in $h$. This capping effect is not unique to $BIV$, $e$, and $h$, or to the matter of perceptual justification. The relevant features of the case are that it's $e$ alone that's being conditionalized upon, that $BIV \vDash e$, that $BIV \vDash \neg h$, and that $\neg(e \vDash h)$ — the capping effect will be the same for any case meeting those conditions.

The situation changes dramatically when we also update upon $h$. Since $h$ and $BIV$ are inconsistent, Probabilism requires that that $P_{old}(BIV \mid h) = 0$. If upon having an experience as of my hands I strictly conditionalize only on $h$, then $P_{new}(BIV) = P_{old}(BIV \mid h)$, and so $P_{new}(BIV)$ must be 0 as well. In other words, if my experience makes it rational to exogenously revise my credence in $h$ to 1 then I'm forced to become maximally confident that I'm not a handless brain in a vat having hand-like experiences. Hence even though I can't be any more confident in $h$ than I am in $\neg BIV$ — after all, (4) is a theorem of the probability calculus — my credence in $\neg BIV$ is already as high as it can go and so my new credence in $h$ is not in any way constrained.

It's important not to interpret this conclusion too strongly. What I have shown is that the formal commitments of Bayesianism do not entail that my credence in $h$ after having an experience as of my hands is limited by my prior credence in $\neg BIV$. What I have not shown, and what I do not believe to be true, is that facts about my epistemic state before I've had an experience as of my hands can never constrain the attitudes that I ought to adopt once I've had that experience.

So what determines whether my justification for believing a defeater at $t_1$ constrains my attitude at $t_2$ toward $h$, or whether at $t_2$ I should change my attitude toward that defeater in light of my new attitude toward $h$? I'm not offering a positive account here, merely pointing out that the formal commitments of the Bayesian do not force an answer upon us. That formalism constrains only the credence revisions that it models and no credence revision immediately resulting from experience is modeled. Hence no credence revision immediately resulting from experience and affected by the agent's possession of a defeater is modeled. The point is simply that if the inputs to the Bayesian model are themselves defeasible then that defeat is an off-model phenomenon and hence will not be constrained or explained by the Bayesian formalism. In other words, it's not that the credence that one ought to adopt in light of an experience is unconstrained by one's preexisting attitudes, but rather that the effects of those constraints are felt outside of the formal model.[16]

We are now in a position to respond to the objection from White that I sketched at the end of section 1.4.2. White objected that even if having an experience as of my hands makes it permissible to exogenously raise my credence in $h$, it also makes it permissible to exogenously revise my credence in $e$, in which case $e$ must be among the propositions that I conditionalize upon. The idea seems to be that this implies (2) — that $P_{new}(\neg BIV) = P_{old}(\neg BIV \mid e)$ — and hence the Dogmatist is still stuck with (5).

White is no doubt correct that having an experience as of my hands provides me with immediate justification for believing that I've had an experience as if I have hands, and so $e$ should be among the propositions that I update upon. It's also true that my posterior credence in $h$ will be capped by my prior credence in $\neg BIV$ if $e$ is the only proposition that I conditionalize upon in response to my experience. I've proposed that agents should update on whatever propositions are immediately justified by their experience, and Dogmatists think that $h$ is one of those propositions. Hence the view that White is objecting to — Bayesian Dogmatism with my proposal for what to update upon — Is one on which the agent ought to update both on $e$ and on $h$. For the Classical Bayesian, updating on $e$ and also on $h$ is equivalent to

[16] David Christensen [1992] has argued that permitting off-model defeat constitutes an unacceptable limitation on the explanatory ambitions of the Bayesian who accepts defeasible inputs to the model and hence poses a serious problem for Jeffrey Bayesianism.

updating on $e\&h$,[17]

and so on this proposal $P_{new}(\neg BIV) = P_{old}(\neg BIV \mid e\&h)$. Since $e\&h$ implies $\neg BIV$, $P_{old}(\neg BIV \mid e\&h)$ and $P_{new}(\neg BIV)$ must both be 1, and so updating on $e\&h$ solves the problem for the Classical Bayesian for exactly the same reason that updating on $h$ alone solves the problem.[18]

So where exactly does the objection go wrong? The assumption seems to be that updating on $e$ is a sufficient condition for producing the capping effect that I discussed above, i.e. it commits the Dogmatist to premise (2) and hence to conclusion (5). But that's just wrong: updating on $h$ in addition to $e$ implies that (2) is actually false,[19] as now $P_{new}(\neg BIV)$ should be set to $P_{old}(\neg BIV \mid e\&h)$ rather than to $P_{old}(\neg BIV \mid e)$.

## 1.5 Varieties of Bayesianism

Let's take stock. Dogmatists are committed to two theses about perceptual justification: that it's immediate, and that it's underminable. Bayesians are committed to two theses of their own: Probabilism and Conditionalization.

[17]Due to the commutativity of Strict Conditionalization, the order of update does not affect the credence function thats ultimately adopted. See Weisberg [2009].

[18]For the Jeffery Bayesian updating on $e$ and on $h$ needn't be equivalent to updating on $e\&h$, but that conjunction will be an element of the partition updated upon, as will $e\&\neg h$, $\neg e\&h$, and $\neg e\&\neg h$. Conditionalizing on this partition involves assigning credences to each of its elements, and $P(h) = P(h \mid e\&h) + P(h \mid \neg e\&h)$, so weighting this partition determines the posterior credence of $h$. Finally, since $h$ is inconsistent with $BIV$ it follows that $P_{new}(BIV)$ can't be any higher than $1 - P_{new}(h)$, and so a high posterior credence in $h$ results in a low posterior credence in $BIV$, regardless of the prior credence in $BIV$. For general remarks on this approach see [Jeffrey, 1983, 173].

[19]Assuming that $P_{old}(\neg BIV) > 0$.

The point of the Bayesian Argument is to show that Bayesianism is inconsistent with the Dogmatist's immediacy thesis by showing that an experience as if $h$ only generates a high posterior credence in $h$ when the agent has a high prior credence in $e\&\neg h$. I've argued that this conclusion follows only with the additional thesis that upon having an experience as of $h$, Bayesian agents ought to update on $e$ and $e$ alone. But updating on $h$ instead of $e$ (or in addition to $e$) is both consistent with Bayesianism and much more natural for the Dogmatist, and hence the Bayesian Argument is unsound.

One potential objection is that although adopting my proposal resolves the apparent conflict between Bayesianism and the *immediacy* of perceptual justification, it appears to create a new conflict between Bayesianism and the *underminability* of perceptual justification.[20] To see the problem, first consider Classical Bayesianism*, the conjunction of Probabilism, Strict Conditionalization, and the Ratio Analysis of conditional probability (we'll back off that assumption in a moment):

**Ratio Analysis:** $P(A \mid B) = \frac{P(A\&B)}{P(B)}$

The Ratio Analysis is important to the present discussion because it commits the Bayesian to invincible certainty: if a proposition is once assigned a credence of either 1 or 0 then it's impossible to revise that credence endogenously. If $P(A) = 1$, then $P(A \mid B) = {}^{P(A\&B)}/_{P(B)} = {}^{P(B)}/_{P(B)}$, meaning

[20]Thanks to Miriam Schoenfield for pressing this objection.

that for any proposition $B$ such that $P(B) > 0$, $P(A \mid B) = 1$. Similarly, if $P(A) = 0$ then $P(A \mid B) = {}^{P(A\&B)}/_{P(B)} = {}^{0}/_{P(B)}$ , and so for any proposition $B$ such that $P(B) > 0, P(A \mid B) = 0$.

Now for the problem. Since Classical Bayesianism* accepts Strict Conditionalization, if that view is correct then in order to update on $h$ I must first exogenously revise $P(h)$ to 1. The Dogmatist is committed to the underminability of my credence in $h$ and so it must be possible to decrease that credence, but given Strict Conditionalization and the Ratio Analysis that's impossible. The lesson is that the Classical Bayesian* can't simultaneously hold that (i) we should update on what we're immediately justified in believing, (ii) upon having a perceptual experience as of $h$ I obtain some immediate justification for believing that $h$, and (iii) my justification for $h$ is underminable. The Dogmatist is committed to (ii) and (iii), and my suggestion is that we accept (i), so my response to the Bayesian Argument is unavailable to the Dogmatist who is also a Classical Bayesian*.

What options are available to the Bayesian Dogmatist at this point? Any Bayesian who accepts the Ratio Analysis is committed to the invincibility of certainty: that boundary credences (0 or 1) can never be revised endogenously. The Classical Bayesian*'s further commitment to *Strict* Conditionalization forces them to assign a credence of 1 to any evidence proposition, and hence the Classical Bayesian* is also committed to the invincibility of evidence. Bayesianism is consistent with the rejection of either thesis, and each holds the promise of yielding a version of Bayesianism that's consistent with defeasible updates.[21]

Consider first what happens if we retain Strict Conditionalization and Probabilism and give up on the Ratio Analysis of conditional probability. The idea here is to accept the equation of $P(A \mid B)$ with ${}^{P(A\&B)}/_{P(B)}$ in all instances in which $P(B) > 0$ and to reject it otherwise (see Hájek [2003]).

Without the Ratio Analysis it's possible to reduce some maximal credences, though only in a limited set of circumstances. Consider some proposition $A$ that I've updated upon at some point in the past. Since we're supposing Strict Conditionalization, I must have assigned credence 1 to $A$ when I updated upon it. As we've seen, that means that for any proposition $B$ such that $P(B) \geq 0, P(A \mid B) = 1$, and so it's impossible to reduce my credence in $A$ by updating on $B$. But if we update on some proposition $C$ such that $P(C) = 0$, we are freed from the constraints of the Ratio Analysis and so there's no formal barrier to assigning $P(A \mid C)$ a value less than 1. Hence for any proposition $A$ that we've previously updated upon and thus become certain is true, we can back away from that certainty only by becoming certain of the truth of some proposition $C$, which we formerly regarded as being certainly false, and updating accordingly.

This is not an appealing way to accommodate undercutting defeat in

[21]A thorough discussion of the independent reasons to prefer Jeffrey Conditionalization over Strict Conditionalization or to reject the Ration Analysis is beyond the scope of this essay. My purpose in this section is instead to identify the version of Bayesianism most amenable to Dogmatism. For broader criticism of the strictness of Strict Conditionalization see [Jeffrey, 1983, ch. 11] and [Williamson, 2000, 203-7]; for a critique of the Ratio Analysis see Hájek [2003].

a Bayesian framework. Even after having an experience as of my hands and updating accordingly it should be possible to increase my confidence in $BIV$ and on those grounds decrease my confidence in $h$. But if I've updated on $h$ and hence set $P(h) = 1$ then by Conditionalization I will also have set my credence in every proposition inconsistent with $h$ — including $BIV$ — to 0. But now how can I increase my credence in $BIV$ from 0? As with all credence revisions, that revision will be either exogenous or endogenous. Once I've set $P(BIV)$ to 0, the only way to revise that value endogenously is to update on some other proposition with a credence of 0.[22] For example, if a very reliable source were to tell me that I'm a brain in a vat after all then I should at least slightly raise my confidence in $BIV$, but on the current proposal that's only possible if I assign a credence of zero to my obtaining that testimony.[23]

Can $P(BIV)$ be revised exogenously? That would be consistent with the formalism, though I won't comment on its plausibility. The problem that I will mention is that given Strict Conditionalization, exogenously revising my credence in $BIV$ means assigning it a credence of 1, which means that upon conditionalizing I must now revise my credence in $h$ all the way back down to

[22]Because we've only rejected the Ratio Analysis in cases in which the proposition being updated upon is assigned a credence of 0. If $P(BIV) = 0$ and $P(A) > 0$ then we're still committed to saying that $P(BIV \mid A) = {}^{P(A\&B)}/_{P(B)=0}$.

[23]Though I've been considering whether Hájek's proposal of abandoning the Ratio Analysis offers a solution to the Problem of Invincible Evidence, Hájek himself was not motivated by that problem. Hájek's objection to the Ratio Analysis is that it makes it impossible to update on propositions assigned a credence of 0. I'm sympathetic — I too 'hold this truth to be self-evident: the conditional probability of any (non-empty) proposition, given itself, is 1' [Hájek, 2003, 286] — so the criticisms in this section should not be interpreted as criticisms of Hájek's proposal.

0, which is not what's wanted in many cases of undermining.

Hence the combination of Dogmatism's commitment to underminable perceptual justification and Strict Conditionalization's requirement that all propositions being updated upon be assigned a credence of 1 is a poor match for my proposal that the Bayesian Dogmatists should update on the contents of experience. Classical Bayesianism and Jeffrey Bayesianism treat boundary credences the same, and so Jeffrey Bayesians have no great advantage when it comes to the defeasibility of credence 1 propositions. Nonetheless, Jeffrey Bayesianism proves far more amenable to my proposal. For either type of Bayesian, evidence is only invincible when it's certain. Given Strict Conditionalization, all evidence is certain and so all evidence is invincible (ignoring the possibility of updating on $P(\cdot) = 0$ propositions). Jeffrey Conditionalization allows updates on propositions that aren't certain, and so evidence needn't be invincible. Hence the (Jeffrey) Bayesian Dogmatist is free to respond to hand-like experience by exogenously revising their credence in $h$ to a value just below 1, thereby preserving its defeasibility.

The combination of Jeffrey Bayesianism and my proposal that we update on the contents of our experience is very appealing. It allows the Dogmatist to retain the core commitments of Bayesianism (Probabilism, a version of Conditionalization, and the Ratio Analysis (if desired)) while avoiding the problematic conclusion of the Bayesian Argument.

## 1.6 Conclusion

The conclusion of the Bayesian argument has always been somewhat surprising. Typically when two theories conflict it's because they offer inconsistent accounts of the same explanandum. Bayesianism and Dogmatism seek to account for different aspects of rationality: respectively, the coherence of partial belief states and the appropriate response to perceptual experience. Hence there is no single explanandum common to both theories. As I've argued, bringing those views into conflict requires an auxiliary account of how they come into contact in the first place.

The success of the Bayesian argument requires a very specific thesis about this point of contact between Dogmatism and Bayesianism: that upon having an experience as of $A$ the agent should exogenously revise their credence in *I've had an experience as if* $A$, with any revision to their credence in $A$ itself proceeding via conditionalization. For Inferentialists that's a very natural way to model perceptual learning, as it makes explicit their view that perceptual justification for $A$ is inferentially dependent on agents having justification for believing propositions about their own mental states. But Dogmatists reject that inferential picture of perceptual justification, claiming instead that an experience as of $A$ can provide immediate justification for $A$. Hence the Dogmatist should view the Inferentialist's modeling proposal as both inaccurate and prejudicial. In short, the Bayesian Argument together with the Inferentialist's approach to modeling begs the question the against the Dogmatist, and the Bayesian Argument without that approach to modeling is unsound.

Either way, the argument provides no reason to reject Dogmatism. The upshot of these considerations is an attractive view combining Dogmatism and Jeffrey Bayesianism, on which the epistemic impact of a perceptual experience is incorporated into the model by making rational an exogenous credence revision to the content of that experience.

# Chapter 2

# Updating, Undermining, and Perceptual Learning

## 2.1 Introduction

On the way home from work I find myself wondering what color my daughter's new bike is. I think it might be blue, or red, or maybe green — I'm not sure. I'm also not sure whether my colleague was joking when he claimed to have slipped a (slow acting) color-hallucination-inducing drug in my afternoon coffee. One thing I am sure about at this point is that facts about my perceptual sobriety and facts about the color of my daughter's bike are evidentially unrelated: since I haven't yet seen the bike, changing my confidence in the one shouldn't affect my confidence in the other. Later I see the bike, and since appears it to be green I become confident that it is green. But something else has changed as well: now if I were to increase my confidence that I'm on color-drugs, I would begin to doubt the veridicality of my perceptual experience as of the greenness of the bike, and as a result I would reduce my confidence that the bike is green. In other words, my belief about whether I'm on color-drugs is no longer evidentially unrelated to my belief about the color of the bike; the former now serves as a potential defeater for the latter. In particular, it's an undermining defeater: instead of telling directly against the truth of *the bike is green*, it tells against the evidential support that I have for believing that proposition.

Jonathan Weisberg [2009], [2015] and Jim Pryor [2013] have argued that the case as described is in tension with the Jeffrey Bayesian's account of perceptual learning. That's because any two propositions that start out probabilistically independent cannot lose that independence as a result of conditionalizing on one of them. Conditionalization being the primary means of rationally permissible credence revision in any Bayesian account of perceptual learning, and the loss of probabilisitic independence being essential to at least some cases of undermining defeat, they conclude that undermining defeat and Jeffrey Bayesianism are in tension or even inconsistent.[1] In this essay I argue that Weisberg's and Pryor's conclusion is overly pessimistic, and that the Bayesian account of perceptual learning is perfectly consistent with undermining defeat.

## 2.2 The Puzzle

I'll begin with a quick sketch of the Bayesian account of perceptual learning that I'll be discussing. Agents assign subjective probabilities or credences to propositions (e.g. $P(A)$), with those assignments subject to norms

[1]Thought both Pryor's and Weisberg's written work supports this reading, in conversation they both take the lesson of the puzzle to be somewhat weaker: Weisberg takes it as a reason to abandon *subjective* Bayesianism for an *objective* version that permits conditionalization directly upon perceptual states, while Pryor takes the lesson to be very similar to what I argue below. In this essay I'll be responding to their written work.

of probabilistic coherence (call that thesis 'Probabilism'). Probabilities are also assigned to propositions conditional on other propositions (e.g. $P(A|B)$), which for our purposes I'll understand as being defined in terms of unconditional probabilities according to the formula $P(A|B) =_{df} \frac{P(A\&B)}{P(B)}$. Perceptual experience leads agents to revise some subset of their credences, which by a process of Bayesian Conditionalization leads to revisions in other credences.

Bayesians understand the process of conditionalization in slightly different ways. According to Classical Bayesians, upon changing credence in $B$ to 1 (due to a perceptual experience, or whatever) the agent updates by setting her new credence in $A$ to her old credence in: $A$ conditional on $B$. In other words, where $P_{old}(.)$ is the probability function accepted by the agent before having the relevant perceptual experience and $P_{new}(.)$ is the function accepted by the agent after having the experience and updating on $B$, Classical Bayesians claim that for any $A$ and $B$,

**Classical conditionalization:** $P_{new}(A) = P_{old}(A|B)$

Jeffrey Bayesians[2] generalize the Classical program by relaxing the requirement that all conditionalization be on propositions assigned a credence of 1. I'll go into more detail about how Jeffrey conditionalization works below,

[2]For the purposes of this essay a Jeffrey Bayesian is any Bayesian who accepts Richard Jeffrey's generalization of the classical rule of conditionalization that I'm calling 'Jeffrey Conditionalization'. Our 'Jeffrey Bayesians' needn't share Richard Jeffrey's particular views about the motivations for accepting that rule (Jeffrey [1992])), Radical Probabilism (Jeffrey [2004]) or anything else.

but here's a rough sketch: the process begins with an assignment of credences to some subset of the propositions to which the agent assigns credences. These credence assignments are laundered (see below) into a partition of the agent's state space, in which that space is divided into an exhaustive and exclusive set of ways that the world might be (the 'elements' of the partition), with each way assigned a credence. Finally, the agent conditionalizes on this partition with its weighted elements — call them the $B_i$ — using the following rule:

**Jeffrey Conditionalization:** $P_{new}(A) = \sum_i P_{old}(A|B_i)P_{new}(B_i)$

With these preliminaries in place, let's return to the puzzle of the color-drugs and the bike. Before seeing the bike I regarded the veridicality of my own color perception as irrelevant to the greenness of the bike, and hence I regarded the propositions *I'm on color-drugs* and *the bike is green* as being probabilistically independent. Taking $P_{old}(\cdot)$ as the probability function that I accepted before having a perceptual experience as of the greenness of the bike, that means that:

(1) $P_{old}(\textit{green} \mid \textit{color-drugs}) = P_{old}(\textit{green})$

After I've had an experience as of the bike being green and shifted my partition accordingly, I adopt the credence function $P_{new}(\cdot)$ that results from the relevant conditionalization procedure. At this point I no longer regard the two propositions as being independent, but instead regard *I'm on color-drugs* as a defeater for *the bike is green*. I'll interpret this as saying that:

(2) $P_{new}(green \mid color\text{-}drugs) < P_{new}(green)$

Weisberg and Pryor observe that the introduction of a negative probabilistic correlation between two propositions through a process of updating on one of them is problematic within the Bayesian framework. That's because Jeffrey Conditionalization is rigid:[3]

**Jeffrey Rigidity:** If $P_{new}(\cdot)$ is the credence function resulting from accepting $P_{old}(\cdot)$ and then updating on a shift in partition $\{B_i\}$, then for any proposition $A$ and any $B_i \in \{B_i\}$, $P_{new}(A|B_i) = P_{old}(A|B_i)$

and rigid updating rules preserve independence:[4,5]

**Rigidity is Independence Preserving (RIP):** If the transition from $P_{old}(\cdot)$ to $P_{new}(\cdot)$ is rigid on partition $\{B_i\}$ and $P_{old}(B_i|A) = P_{old}(B_i)$ for every $B_i \in \{B_i\}$, then $P_{new}(B_i|A) = P_{new}(B_i)$ for every $B_i \in \{B_i\}$

Hence Weisberg's puzzle, as I'll call it, is this: our intuitions about undermining defeaters commit us to both (1) and (2), but if learning from an

[3] See Jeffrey [1992, p. 80] and Weisberg [2015, p. 125].

[4] See Weisberg [2015, p. 126]. For the Classical versions of the Rigidity and RIP principles take the partition to consist of a single cell weighted to 1.

[5] The independence-preserving nature of rigid update rules also creates problems for what we might call 'promoters'. My confidence that the bike is green might be very high after an experience as of its greenness, and then become higher still when I learn that I'm on drugs that make my color-perception especially reliable. This would require that my new credence function include a *positive* correlation between those propositions, which cannot be introduced via a rigid updating rule (assuming that were independent before the experience). Thanks to an anonymous referee for pointing this out.

experience as of a green bike involves updating on *the bike is green* using a rigid updating rule such as Jeffrey Conditionalization, then that combination is impossible.[6,7] As Weisberg puts it, "...[perceptual underminers are] irrelevant to the supported proposition at first, but negatively relevant after the perceptual state has lent its support. And this is precisely what 'Rigidity is Independence Preserving' rules out. If the underminer is irrelevant before the perceptual state supports the proposition, it is irrelevant after as well. So Rigidity prevents perceptual undermining when it obviously shouldn't."

[6]One could model the undermining effect of *I'm on color-drugs* on *the bike is green* by updating instead on something like *it appears as if the bike is green*, which in turn raises my credence in *the bike is green* only if I already have a low credence in *I'm on color-drugs*. This allows us to regard anything that raises that last credence as an undermining defeater for the greenness of the bike; in the language of Pryor [2013] this could be modeled as a case of 'quotidian' undermining. This is beside the point. Weisberg's puzzle presents a problem for anyone who thinks that the propositions conditionalized upon — whatever those happen to be — can themselves be undermined, and so updating upon beliefs about how things seem offers a solution only if we agree that (i) *those* beliefs cannot be undermined, and (ii) all cases of undermining defeat are quotidian. An evaluation of that approach is outside of the scope of this essay – I'll be arguing that the Bayesian has a solution to Weisberg's puzzle requiring neither indefeasible updates nor pan-quotidianism about undermining defeat.

[7]Note the conditional structure of the preceding sentence. An alternative possibility is that episodes of perceptual learning that seem to require failures of Rigidity are simply inapt to be modeled using Jeffrey Conditionalization. Jeffrey thought of Rigidity not as feature of Conditionalization, but as a precondition for that rule's applicability (see [Jeffrey, 1970, 172-9]). Since what I learn from my experience as of the greenness of the bike is vulnerable to undermining defeat, this case seems to require just such a failure of Rigidity, and so in this case the precondition is not satisfied and Jeffrey Conditionalization does not apply. Weisberg implicitly rejects this picture, proceeding as if Jeffrey Conditionalization either must apply in every case of perceptual learning or it must be rejected. Since Jeffrey Conditionalization is rigid, he reasons, it doesn't apply to cases of perceptual learning that are vulnerable to undermining defeat, so it doesn't apply to every case, so it must be rejected. (For more on this dispute, see §2.5.) I argue that neither side has it quite right: pace Jeffrey, Conditionalization applies in all cases of perceptual learning, and Pace Weisberg, this needn't lead to Rigidity failures, so this creates no significant problem for Jeffrey Conditionalization.

[Weisberg, 2015, p. 126]

## 2.3 Bayesian Learning More Carefully

Below I'll be arguing that Weisberg's conclusion is too strong, but in order to do so we must first take a closer look at Bayesian perceptual learning and the ways that it's constrained by Rigidity.

### 2.3.1 Bayesianism is Incomplete

Bayesianism is at best an incomplete theory of epistemology, in the sense that there are at least two very important varieties of constraints upon rational credence assignments that it is unable to explain. The first variety of incompleteness concerns rationally permissible *starting credence functions*, functions held by agents who possess no evidence at all (so-called 'super-babies'). There are many intuitively impermissible starting credence functions that are nonetheless perfectly consistent with Probabilism, and hence whose impermissibility cannot be explained by anything within the Bayesian formalism. An agent's choice of starting credence function will of course determine how perceptually acquired information is to affect other credences via conditionalization, as it will determine their conditional probabilities.

I'll return to the significance of the Bayesian formalism's underdetermination of rationally permissible starting credence functions in §2.5, but right now I want to focus on another type of incompleteness in the Bayesian account of perceptual learning. Just as Probabilism alone is too weak to rule out all of the intuitively impermissible starting credence functions, Conditionalization is too weak to rule out all intuitively impermissible credence revisions. That's because not all permissible credence revisions proceed via Conditionalization, and those that don't are only minimally constrained by the Bayesian formalism.

The most important credence revisions that don't proceed via conditionalization come as a result of a perceptual experience. Why am I rational in believing that the stove is warm? Because it feels warm. Why am I rational in believing that the cat is on the mat? Because I had a perceptual experience as of a cat on the mat. Those *experiences* make it rationally permissible to form those beliefs.[8] On the sort of subjective Bayesian picture that we're considering, probabilities are understood as partial belief states, and the only sorts of things that can be partially believed are *propositions*. Experiences as of warm stoves or cats on mats might have propositional content (I think that they do), but they are not themselves propositions and so they cannot be assigned credences. Hence they are not the sorts of things that can be conditionalized upon. Hence Conditionalization cannot be the whole story when it comes to rationally permissible credence revisions.[9]

[8]For those who prefer a picture on which agents update on propositions about how things seem rather than how things are, the question becomes: why am I rational in believing *I've had an experience as of a cat on the mat*? The answer is the same: because of my experience.

[9]Note how minimal I've been in describing the role of experience in fostering rationally permissible credence revision. The point applies not only to those (such as myself) who think that a perceptual experience can be *evidence* that *justifies* belief, but also to those who think that it can play only a non-evidential, non-justificatory role in making certain beliefs or credence revisions rationally permissible (e.g. Davidson, Jeffrey, and Williamson).

Bayesians construct formal models of rationally permissible credence revisions, and all of the revisions that they model proceed via conditionalization. As we've seen, many rationally permissible credence revisions do not proceed via conditionalization and hence not all rationally permissible credence revisions are modeled. This distinction will be important to what follows, so I'll introduce some terminology: call the revisions modeled by the Bayesian *endogenous* credence revisions (as in *endogenous to the model*), and call the rest *exogenous* revisions.[10]

### 2.3.2 Rigidity and Independence, Carefully This Time

With the distinction between endogenous and exogenous revisions in mind, let's take a closer look at the rigidity of Conditionalization. To that end (and I swear this is relevant) note that it's common for a single perceptual experience to affect one's rational confidence in many different propositions. For example, if I have a perceptual experience as of a red, spherical ball, I might shift my confidence in *the ball is red* and *the ball is spherical*, along with lots of other propositions (experience is pretty rich, after all). Though the details of how to model this phenomenon will differ slightly on the Jeffrey and the Classical Bayesian accounts, they share some important similarities, and in both cases those details have important implications for the rigidity of Bayesian perceptual learning.

Consider first how the Classical Bayesian will model a case in which

[10]See [BLIND]; the terminology originates with Howson and Urbach [1993, p. 82].

an agent exogenously revises her credence in more than one proposition at a time. At $t_1$ Clara accepts a credence function such that $P_{t_1}(A) = P_{t_1}(B) = P_{t_1}(A|B) = .5$, and then at $t_2$ she exogenously shifts her credences in $A$ to 1 and in $B$ to 1. As discussed above, this exogenous shift alone will fix some subset of her credences at $t_2$ — in this case that set will include her credences in $A$ and in $B$ — with others being determined by conditionalizing upon that subset. But what exactly does it mean to update not on a single proposition, but on a set of propositions? For the Classical Bayesian, the answer is very simple: update on all of the new evidence acquired by updating on the conjunction of all of the propositions whose probabilities have just been exogenously revised to 1, which in this case means updating on $A\&B$.

Classical conditionalization is rigid, meaning that updating on $A\&B$ never changes the probability of any other proposition conditional on $A\&B$. Importantly, though, conditionalizing on that conjunction will not in every case preserve the probability of some proposition $C$ conditional on one of the conjuncts of that conjunction, i.e. $P(C|A)$ or $P(C|B)$. Suppose for reductio that that's false, and so for any $A$, $B$ and $C$, $P(C|A) = P_{A\&B}(C|A)$. No matter what values are assigned to $P(C|A)$ and $P(C|A\&B)$, it must be the case that $P_{A\&B}(C|A) = P_{A\&B}(C|A\&B)$; after all, at that point I've assigned a credence of 1 both to $A$ and to $A\&B$. The rigidity of Conditionalization ensures that $P_{A\&B}(C|A\&B) = P(C|A\&B)$, and so given our supposition it follows that $P(C|A) = P(C|A\&B)$ for any $A$, $B$ and $C$. But this last equality is often false — my credence that the table is delicate given that it's made out of glass is much higher than my credence that it's delicate given that it's made out of glass and it's incredibly sturdy — and so our supposition is false.

The lesson so far isn't that Classical Conditionalization isn't rigid; it is. The two-part lesson is that (i) the proposition that's conditionalized upon might be just one of the many propositions that are exogenously revised, and (ii) though Classical Conditionalization is rigid with respect to the one proposition that's conditionalized upon, it's not rigid with respect to those other exogenously revised propositions.

Having appreciated both (i) and (ii) we're now in a position to sketch a possible response to Weisberg's puzzle. As far as that puzzle goes, Rigidity is only interesting because rigid updates preserve independence between the proposition updated upon and other propositions. This is puzzling only if we assume that the propositions losing their independence with potential underminers are the ones that we update upon directly, rather than conjuncts in a larger conjunctive proposition that we update upon. If we drop that assumption, then we are free to concede the rigidity of Conditionalization without thereby conceding that Conditionalization preserves the independence of exogenously revised, perceptually justified propositions with their potential underminers.

Below I'll develop this response on behalf of the Jeffrey conditionalizer, but first let's note that it's hopeless for the Classical conditionalizer. The case here is overdetermined, but I'll mention just one reason that's particularly salient to our discussion. Classically conditionalizing upon $A\&B$ requires assigning assigning it a credence of 1, which requires assigning $A$ a credence of 1. But any proposition assigned a credence of 1 is probabilistically independent of any other proposition[11], and so any proposition that's been updated upon, or any of their logical implications, will be independent of all other propositions. It follows that if $A$ and $C$ are independent before I Classically conditionalize on $A\&B$, then they'll be independent afterward. Hence while Classically conditionalizing on $A\&B$ can *change* credences conditional on $A$ or on $B$, it can't *destroy the independence* of $A$ or $B$ with some other proposition.

Jeffrey conditionalization avoids this particular problem by allowing updates on propositions with credences less than 1. For example, Jeffrey Bayesianism describes how to conditionalize when an experience makes it rationally permissible to exogenously revise my credence in *the ball is red* to .7 and my credence in *the ball is spherical* to .9. But this creates a new problem: while the Classical Bayesian can handle cases of multiple propositions whose credences have been revised exogenously by conditionalizing on their conjunction, in most cases this move is unavailable to the Jeffrey Bayesian. A probability assignment of 1 to each conjunct ensures that the probability of the conjunction will be 1 as well, but assignments of probabilities between 0 and 1 to both conjuncts is consistent with a range of probability assignments to their conjunction. For example, if I think that $P(\mathit{red}) = .7$ and $P(\mathit{spherical}) = .9$, the value of $P(\mathit{red}\ \&\ \mathit{spherical})$ can be anywhere between .6 and .7, and where in that interval the probability of that conjunction lies is undetermined by the

[11] Assuming that the propositions in question have credences greater than zero.

probabilities of the conjuncts themselves.

Jeffrey conditionalizers face a second complication in selecting what to conditionalize upon. While Classical Bayesians update on a weighted *proposition*,[12] Jeffrey Bayesians update on a weighted *partition* of the state space, where a partition is simply a division of that space into mutually exclusive and jointly exhaustive parts, each weighted according to its probability. Propositions such as *the ball is red* and *the ball is spherical* are neither exclusive nor exhaustive, and so they typically won't partition the relevant state space (though they might: see fn. 13).

Jeffrey [1983, p. 173] resolves the issue in a very simple way. He begins by identifying an initial set of propositions — he calls them 'originating propositions' — whose probabilities shift exogenously, but which typically are not elements of the partition. Those elements are instead conjunctions constructed by taking each originating proposition or its negation as a conjunct. For example, taking $A$ and $B$ as our originating propositions we wind up with four conjunctions as our partition elements: $A\&B$, $A\&\neg B$, $\neg A\&B$ and $\neg A\&\neg B$. These four conjunctions (Jeffrey calls them 'atoms'; I'll follow more recent authors and call them 'elements') are mutually exclusive and jointly exhaust any probability space, so taking each conjunction as one of our $B_i$'s, the set $\{B_i\}$ will form a partition, allowing us to Jeffrey conditionalize upon it.[13]

[12]This is slightly misleading — see fn. 13.

[13]Many authors — Weisberg and Pryor included — omit this aspect of Jeffrey's theory in their summaries. I speculate that this is because in certain circumstances the effect of updating on the originating propositions and updating on the elements is the same, and

With all of this in mind, let's revisit Rigidity with an eye to clarifying precisely what's rigid with respect to what on the Jeffrey picture. Recall that Rigidity says:

**Jeffrey Rigidity** If $P_{new}(\cdot)$ is the credence function resulting from accepting $P_{old}(\cdot)$ and then updating on a shift in partition $\{B_i\}$, then for any proposition $A$ and any $B_i \in \{B_i\}$, $P_{new}(A|B_i) = P_{old}(A|B_i)$

We've just seen that each $B_i \in \{B_i\}$ is a conjunction of originating propositions, not an originating proposition itself. Hence what Jeffrey Rigidity rules out is a change in conditional probabilities on conjunctions of originating propositions, not changes in conditional probabilities on the originating propositions themselves. As with Classical conditionalization, the probabilities of the individual conjuncts — the originating propositions — conditional on other propositions will not be so-constrained.

because Jeffrey's most widely discussed example of how his system works just happens to be one of those circumstances. In the example we are asked to imagine seeing a cloth in poor lighting, which results results in exogenous revisions to the probabilities of *the cloth is green (=G), the cloth is blue (=B)* and *the cloth is violet (=V)*. Strictly speaking, this should lead to an update on a partition whose elements include the eight ($= 2^3$) conjunctions that we can construct from those three originating propositions, yet Jeffrey (together with many later authors discussing this example) omits discussion of the conjunctions and simply talks of updating on these three propositions. The reason that this isn't disastrous in the current case is because we're asked to also suppose that the agent seeing the cloth is already certain that nothing is more than one color (all over, at the same time, etc) and is also certain that the cloth is either green, blue or violet. Given those suppositions the probability of five of our eight conjunctions is zero, and so they can safely be ignored as elements of the partition. The three remaining conjunctions will each be closely identified with one of our originating propositions: *the cloth is green* with $G\&\neg B\&\neg V$, *the cloth is blue* with $\neg G\&B\&\neg V$, and *the cloth is violet* with $\neg G\&\neg B\&V$. Given the particulars of the case it's harmless to speak of updating on a partition with elements $G, B$, and $V$, but since those particulars will not generally obtain this harmlessness does not generalize.

Consider again my perceptual experience as of the red, spherical ball. Before that experience I assigned a probability of .5 to each proposition, and I assign $P_{old}(red \mid spherical) = .5$. Upon having that experience I set $P_{new}(red)$ to .7 and $P_{new}(spherical)$ to .9. Since those originating propositions don't form a partition, I now need to assign credences to the four relevant conjunctions. Suppose that I do so as follows:

$P_{new}(red \ \& \ spherical) = .6$

$P_{new}(red \ \& \ \neg(spherical)) = .1$

$P_{new}(\neg(red) \ \& \ spherical) = .3$

$P_{new}(\neg(red) \ \& \ \neg(spherical)) = 0$

Now my credence in $P_{new}(red \mid spherical) = ^2\!/_3$. We therefore have a case analogous to the one observed above: we have an episode of perceptual learning in which the probability of an originating proposition on something else has changed, all while respecting the rigidity of Jeffrey conditionalization.

That's the first lesson of this example. The second lesson is actually a bit more interesting. The exogenously revised values that I assigned to my two originating propositions constrain the values that I assign to the elements of my partition — to my four conjunctions — but do not determine them completely. Since (i) the probability of *the ball is red* conditional on *the ball is spherical* is by definition (we are supposing) the ratio of their conjunction to the unconditional probability of *the ball is red*, and (ii) the probabilities of two propositions underdetermines the probability of their conjunction, it follows that (iii) assigning probabilities to two originating propositions (sometimes) underdetermines the probability of one of them conditional on the other. For example, I might just as easily have assigned the following credences after my observation of the red, spherical ball:

$$P_{new} * (\textit{red} \ \& \ \textit{spherical}) = .7$$

$$P_{new} * (\textit{red} \ \& \ \neg(\textit{spherical})) = 0$$

$$P_{new} * (\neg(\textit{red}) \ \& \ \textit{spherical}) = .2$$

$$P_{new} * (\neg(\textit{red}) \ \& \ \neg(\textit{spherical})) = .1$$

In that case my credence in $P_{new} * (\textit{red} \mid \textit{spherical}) = 7/9$, yet just as before my credences in *the ball is red* and *the ball is spherical* are .7 and .9, respectively.

The probabilities assigned exogenously to originating propositions are only minimally constrained by the Bayesian formalism. As we now see, even once those probabilities are selected the probability of their conjunction is underdetermined, and hence the probability of one originating proposition conditional upon another is also underdetermined. It's frequently the case that experience makes it rationally permissible to revise the probabilities of several originating propositions at once, and as a result it's frequently necessary for agents to go further and determine the values of their conjunctions in order to form the partition required for updating. The upshot, then, is that perceptual learning as understood by the Jeffrey Bayesian effectively involves changes to conditional probabilities that are unmediated by Jeffrey conditionalization and hence are unconstrained by Rigidity.

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We're now in a position to draw a broader lesson regarding the significance of the rigidity of Conditionalization for Bayesian perceptual learning. Episodes of perceptual learning involve an exogenous assignment of credences to some propositions (as a result of an experience or something else) and also an endogenous assignment of credences (via Conditionalization) to others. The endogenous assignments reflect the bearing of the exogenously set credences upon the rest.

Weisberg correctly points out that the rigidity of conditionalization prevents the introduction of probabilistic entanglement between *the bike is green* and *I'm on color-drugs* via conditionalization. But the intuition driving Weisberg's Puzzle is not that the probabilistic entanglement is introduced via conditionalization, but merely that it's one result of my perceptual experience.

As we've seen, the Bayesian account of perceptual learning involves more than just Conditionalization: it also involves exogenous credence revisions that don't proceed via Conditionalization. Moreover, those exogenous revisions commonly result in changes to the probability of one originating proposition conditional upon another, as we saw in the case of the red, spherical ball. Finally, even once the exogenously set unconditional probabilities of our originating propositions are determined, there's considerable flexibility in setting their new conditional probabilities.

## 2.4 Formal Proposal

My proposed response to Weisberg's puzzle is fairly simple. Intuitively, having a perceptual experience as of the greenness of my daughter's bike should result in (i) an increase in my confidence in *the bike is green*, (ii) no change to my confidence in *I'm on color-drugs*, and (iii) the introduction of a negative correlation between *I'm on color-drugs* and *the bike is green*, i.e. it should now be the case that $P_{new}(green \mid color\text{-}drugs) < P_{new}(\ green)$. Rigidity prevents the introduction of this negative correlation endogenously via conditionalization on a partition that includes *the bike is green* as an element, and so it must not be an element of the partition. Assuming that my confidence in that proposition is to be increased exogenously, the introduction of the negative correlation in (iii) requires that my new credence in both *the bike is green* and *I'm on color-drugs* must be among the conjuncts of the elements of the input partition. Hence what must happen is that my credence in both of those propositions must be set exogenously.

I'll defend this proposal in §2.5, but for now let's just get a sense for how it works out formally. We take as our originating propositions *the bike is green* (=$G$) and *I'm on color-drugs* (=$D$), and hence we partition our state space into four elements, correlating with the four possible combinations of those propositions and their negations. For simplicity assume that each of the four elements starts out with a probability of 1/4. The introduction of the negative correlations looks like this:

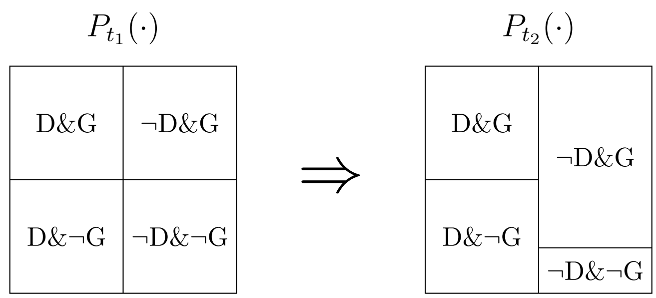


Figure 2.1: Introduction of negative correlation between $D$ (= I'm on color drugs) and $G$ (= the bike is green).

Here my confidence that I was on color drugs when I had my perceptual experience as of the green bike hasn't changed, and my confidence that the bike is green has increased. If we suppose that *I'm on color-drugs* is a complete undermining defeater — a defeater that deprives the perceptual experience of all of its evidential force — then if I were to become certain that I was on color drugs, then my epistemic situation vis-à-vis *the bike is green* before I had the perceptual experience should be the same as my situation after having the experience and becoming certain of the underminer. In pictures:

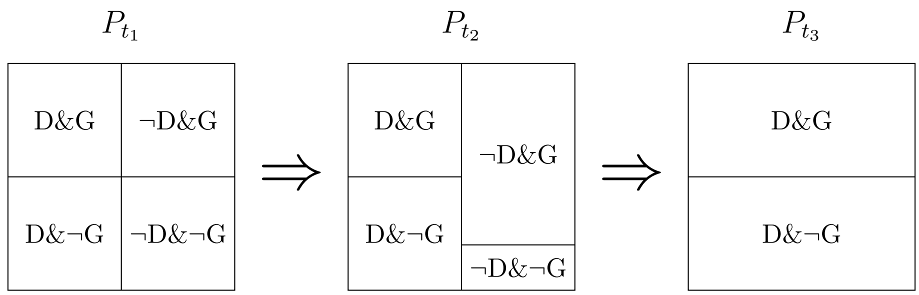


Figure 2.2: Becoming certain of a full undermining defeater.

If at $t_3$ I become more confident that I was on color drugs without becoming certain of it the result is a net decrease in the $G$ space:

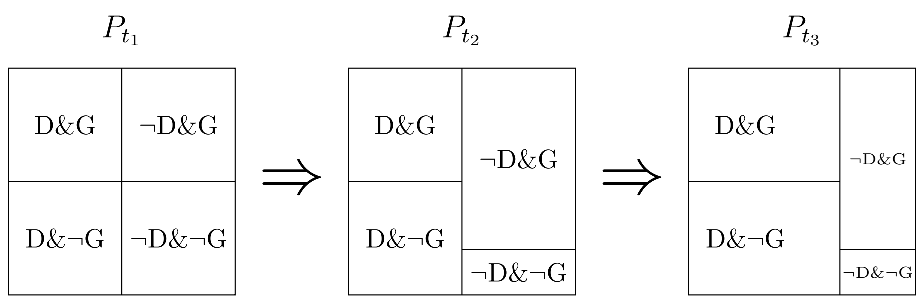


Figure 2.3: Increased confidence in a full undermining defeater.

What if instead of varying my degree of confidence in a full undermining defeater, we vary the degree to which $G$ is undermined? For example, suppose that the color-drugs only somewhat decrease the reliability of my color perception, so that $D$ is a *partial* undermining defeater. This will be set at that initial exogenous revision in response to the experience. The particular mechanism will be that it will increase the size of the $D\&G$ space at the expense of the $\neg D\&G$ space, where a greater increase means a weaker undermining effect.

Assuming that this doesn't reduce my new (at $t_2$) credence of $G$, that means that the ratio of $\neg D\&G$ to $\neg D\&\neg G$ will decrease sightly. If my confidence in $D$ increases at $t_3$ (but not quite to 1) the picture is that of Figure 2.4:

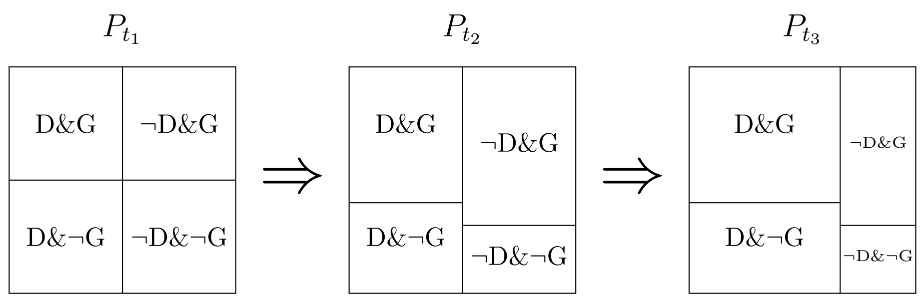


Figure 2.4: Uncertainty in a partial undermining defeater.

## 2.5 Defending the Proposal

Weisberg's puzzle illustrates that the introduction of a negative probabilistic correlation between an originating proposition and its potential undermining defeater cannot be modeled within the Bayesian formalism. Weisberg takes this to be a reason to reject Bayesianism. I have proposed instead that it is a reason to move the introduction of that correlation outside of the model, so that it is already achieved once Conditionalization is applied to the partition. I've shown that this is consistent with Jeffrey Bayesianism, which already assumed the existence of credence revisions taking place off-model (exogenous revisions) that can change conditional probabilities on propositions involved in those off-model revisions, and so includes a formal mechanism for incorporating those revisions into the model.

Weisberg [2015, p. 142-5] anticipates this type of response, calling it the 'appeal to richer inputs', and raises two objections. His first objection is that my proposal requires input partitions that are far more complex than the simple four or eight cell partitions that I've diagramed in §2.4. After all, there are lots and lots of potential underminers for instances of perceptual learning, and each of them will need to become negatively correlated with the proposition that they have the potential to defeat. On my proposal each of those propositions will need to be treated as an originating proposition, and as a result the input partitions will be fairly fine-grained. Moreover, because the determination of which fine-grained partition to adopt given a particular experience will take place outside of the formal model, my proposal involves a loss of explanatory power for Bayesianism. I'll return to this objection below.

More troubling to Weisberg than a mere loss of explanatory power is exactly what is being left unexplained:

> An update rule is supposed to determine our new credences as a function of our old beliefs and the new evidence. But on the current proposal, "the new evidence" is not really the new evidence. The complex distribution we would be plugging into Jeffrey conditionalization would be produced by considering how an experience as of a red-looking sock and our background beliefs about optics combine to warrant new beliefs about the quality of the air and the colour of the sock. And this is precisely the kind of work our update rule was supposed to do. (*ibid.* 144)

This second objection to my proposal can be interpreted in two ways, each of which amounts to (i) a proposed criterion of adequacy for any update rule, and (ii) the claim that if my proposal is accepted, then Conditionalization does not satisfy this proposed criterion. In each case I'll just grant (ii), and instead argue that (i) is not a criterion that Conditionalization needs to satisfy. I'll be assuming that Weisberg is objecting to 'the current proposal' in particular, rather that Bayesianism as such. Given that assumption, if Weisberg's objection successful, then he must have identified some problem for Jeffrey Conditionalization together with my proposal that does not arise for Jeffrey Conditionalization alone. I argue that there is no such problem, and hence if Jeffrey Conditionalization is broadly acceptable as an update rule, then so is Jeffrey Conditionalization together with my proposed constraint upon input partitions.

The two interpretations of Weisberg's criterion are distinguished by what we take the 'new evidence' to be. Like Weisberg, I think that perceptual experience is one type of evidence. This suggests an interpretation of Weisberg's criterion on which any adequate update rule must take experiences and old beliefs as inputs and determine new beliefs as outputs. The problem with Weisberg's criterion so-interpreted is that the 'kind of work' that's being demanded of Conditionalization is one that no Bayesian update rule — Classical or Jeffrey, with my proposal or without — is capable of doing.

The problem is that perceptual experience is the wrong sort of thing to be conditionalizing upon. As discussed in §2.3.1, only *endogenous* credence revisions are governed by a Bayesian update rule, and the only thing that can spark an endogenous revision is an exogenously revised credence. Having a perceptual experience and exogenously revising a credence are two very different things,[14] and hence we never conditionalize upon perceptual evidence. It follows that if the adequacy of an update rule demands that it take us from 'old beliefs and... new evidence' (in the form of an experience) to a new credence function, then Jeffrey conditionalization is not an adequate update rule. It thus becomes clear that Weisberg is objecting to Jeffrey Conditionalization as such, which contradicts my original assumption that Weisberg is taking aim the current proposal in particular.

Some authors deny that experience can serve as evidence. Taking inspiration from Davidson [1986, p. 311], Richard Jeffrey [1983, p. 184-5, 211] holds that only a belief can justify a belief (i.e. can be evidence), and since experiences aren't beliefs it follows that experiences can't be evidence. On his (and Davidson's) view, experience may *cause* credences to shift, but those shifts are inapt for rational evaluation and hence not within the purview of epistemology. Williamson [2000, p. 197-200] thinks something very similar: though only known propositions count as evidence, some propositions are known *because* (yes, that's his term) of the agent's experiences, which are not themselves evidence.

If all evidence is propositional, then my objection to Weisberg's crite-

[14] See Plantinga [1993, p. 82-3].

rion (first interpretation) of adequacy for an update rule is moot, as Conditionalization is now capable of taking agents from old beliefs and new (propositional) evidence to new credences. But this response is inconsistent with the spirit of the criterion, which seems to be that an update rule should model the epistemic significance of experiences, whether or not we label those experiences 'evidence'; this is something that Conditionalization cannot do. For Davidson and Jeffrey, note that two agents with identical beliefs/ credence functions might not be rationally alike, as one might have some beliefs caused by a perceptual experience, and hence capable of justifying other beliefs, while the other has beliefs with some other causal origin; one agent possesses propositional evidence that the other agent lacks. On this view the epistemic difference between the two agents can't be explained without accounting for the etiology their beliefs, which will require an account of the relationship between propositions and experiences — between propositions and non-propositions — something Bayesians cannot do within their formal model. Hence even for someone with Jeffrey-like views on perceptual justification, conditionalization cannot satisfy the spirit of Weisberg's criterion.[15]

Williamson's views are a bit more complicated. Whereas for Jeffrey *beliefs* caused by experience can be evidence for other propositions, Williamson thinks that only *knowledge* plays that role. If Jeffrey is right, then we can hold the initial beliefs fixed while changing the epistemic status of inferred beliefs

[15]I don't mean to suggest that Jeffrey himself ever thought that it could do something like that; he didn't. I want simply to dispense with the notion that adopting Jeffrey's views on evidence renders conditionalization consistent with Weisberg's criterion.

by changing the etiology of those initial beliefs. But if it's *knowledge* that serves this evidential role, then that same trick won't work, at least not given the rest of Williamson's view. Williamson thinks that evidential relations are objective relations between propositions: input a set of evidence propositions (the ones that the agent knows) into their credence function and out comes the probability that ought be assigned to every other proposition (op. cit. §10.2). Against Bayesians he claims that this probability function itself (in contrast to its inputs) is eternal/ insensitive to the beliefs of the agent. On this view it really doesn't matter *why* or *on what grounds* the agent knows evidence proposition $A$, only that it is known.

Nonetheless, Williamson's update rule is also inconsistent with the spirit of Weisberg's criterion. After all, the epistemologist will still want to know why, in virtue of what, particular agents have the evidence that they do in fact have/ know the things that they know non-inferentially. In some cases the agent will know that $A$ in virtue of their experiences. The epistemological significance of experience does not disappear simply because we stop calling it 'evidence'. (As above, I don't mean to suggest that Williamson thinks otherwise.)

On the first interpretation of Weisberg's criterion, the objection is that if my proposal is accepted, then the inputs to Jeffrey conditionalization cannot include new experiential evidence, and hence that that rule cannot 'determine our new credences as a function of our old beliefs and the new [perceptual] evidence'. I've argued that that's a feature of every version of Bayesian conditionalization, and hence that it's not a special problem for my proposal.

On the second interpretation of Weisberg's criterion, the complaint is not that my proposal requires updates on partitions rather than experiences, but that the partitions that my proposal requires are defective, and that this defect is not shared by versions of Jeffrey Conditionalization that do not adopt my proposal. This putative defect is not formal; formally speaking Jeffrey Conditionalization can take any weighted partition of the agent's old beliefs as an input. Instead the objection seems to be couched in a specific idea about the role that an update rule should play in a complete theory of perceptual learning.

A complete theory of perceptual learning would be one that satisfies the first interpretation of Weisberg's criterion: it would determine new beliefs from old beliefs and experiences; it would be a theory of the form:

$$\boxed{\begin{array}{c}\text{experience}\\ + \\ \text{old beliefs}\end{array}} \longrightarrow \boxed{\text{new beliefs}}$$

Figure 2.5: The form of a complete theory of perceptual learning.

In contrast, Jeffrey Conditionalization is of the form:

weighted partition + old beliefs $\longrightarrow$ new beliefs

Figure 2.6: The form Jeffrey Conditionalization.

If Jeffrey conditionalization is to have any role to play in a complete theory of perceptual learning, then there must be a part of that theory that spells out how experiences determine the inputs to conditionalization: weighted partitions. Hence any complete theory of perceptual justification that is broadly Bayesian in nature will consist in two distinct update rules: a heretofore unknown rule that determines a weighted partition from the experience (possibly together with old beliefs – more on this below), and conditionalization, which determines new beliefs as a function of old beliefs plus that partition. The form of this broadly Bayesian theory of perceptual justification is:

experience + old beliefs[?] $\longrightarrow$ weighted partition + old beliefs $\longrightarrow$ new beliefs

Figure 2.7: The form of a broadly Bayesian theory of perceptual learning.

We're now in a position to begin fleshing out the second interpretation of Weisberg's criterion. The question turns on the role of old beliefs in determining the weighted partitions that agents update upon. When Weisberg objects to partitions determined by 'considering how an experience as of a red-looking sock and our background beliefs about optics combine to warrant new beliefs about the quality of the air and the color of the sock' because 'this is precisely the sort of work that our update rule was supposed to do', he's suggesting that background beliefs should not play a role in partition determination. Instead the partition should be identified with the direct epistemic effects of the experience, i.e. those credence revisions that are unmediated by background beliefs.

My proposal does not satisfy this version of Weisberg's criterion because it requires that some propositions that are not directly affected by experience appear in the partition as originating propositions: the undermining defeaters for the other originating propositions in that partition. On my proposal, if my experience as of the red, spherical ball leads me to increase my confidence in *the ball is red* and also come to regard *I'm on color-drugs* as an undermining defeater for that proposition, then both of those propositions must appear in the partition as originating propositions. But it will not generally be the case that such an experience will directly affect my beliefs about my own color-sobriety, so the partition is underdetermined by those direct effects.

As before, however, this version of Weisberg's criterion amounts to a general indictment of Jeffrey conditionalization rather than of my proposal in particular. The general problem is that in very many cases, at least some of the agent's posterior credences will be determined neither by the experience alone — they will not be among the direct effects of the experience — nor by conditionalizing upon those direct effects. As a result, some indirect effects of experience will be determined exogenously, so Jeffrey conditionalization will fail to do the 'kind of work' that Weisberg's criterion (second interpretation) demands of any adequate update rule.

To illustrate, suppose that we reject my proposal and retain Jeffrey Conditionalization. Plausibly, among the direct effects of my experience as of the red, spherical ball are an increased credence in *the ball is red* and an increased credence in *the ball is spherical*, and so presumably those propositions will be among the originating propositions in my partition. Supposing further that these are the *only* relevant originating propositions, the partition will contain four conjunctions as elements: *red* & *spherical, red* & ¬*spherical,* ¬*red* & *spherical,* ¬*red* & ¬*spherical.* That means that my credence in each of those conjunctions will be revised exogenously, i.e. not via conditionalization.

Is it plausible to claim that my credence in each of those conjunctions is in every case determined solely by experience, with no input from background beliefs? I'm inclined to say no, and my inclination only strengthens once we drop the simplifying supposition that our conjunctive partition elements are composed of only two conjuncts each. For in addition to appearing red and spherical, the ball might appear to be dirty, punctured, and three feet to the left of the tree,[16] in which case our partition elements have at least five conjuncts. I feel no inclination to say that my credence in the following is a direct effect of my experience: *red* & ¬*spherical* & ¬*dirty* & *punctured* &

[16]There's no reason to stop at five ways that he ball might appear; experience is pretty rich, after all.

$\neg$*three feet to the left of the tree.*[17]

One more example to drive the point home. By the definition of conditional probability, once $P(A\&B)$ and $P(\neg A\&B)$ are determined, so is $P(A|B)$. That means that if both $A$ and $B$ are originating propositions in an exogenously determined partition, then once the weighted elements of that partition are determined, the probabilities of each originating proposition conditional on every other originating proposition are determined as well. For example, the partition described in the previous paragraph would determine my credence that the ball is not red given that it's punctured, and also my credence that it's dirty and not three feet to the left of the tree given that it's not spherical. As before, I feel no inclination to say that these credences are among the direct effects of my experiences, and yet they aren't determined via conditionalization either. Hence even without my proposal, it's not plausible that the input partitions required by Jeffrey conditionalization are determined entirely by experience.

I have proposed that the best way for Bayesians to accommodate the phenomenon of perceptual learning that is itself vulnerable to undermining defeat is to include potential undermining defeaters among the originating propositions of the input partition, and hence to determine the negative correlation between defeater and new belief exogenously. The identity of and

[17]To be clear: the issue is whether my credence in the *conjunction* is determined by experience alone, not whether my credence in each *conjunct* is so-determined. Note that it is not generally the case that the probability of a conjunction is determined by the probabilities of its conjuncts.

the posterior credence in those underminers are not plausibly among the direct effects of experience, and hence Jeffrey Conditionalization together with my proposal does not satisfy the second interpretation of Weisberg's criterion: some indirect effects of experience are determined independently of Conditionalization. But as I've argued, this is not a radical departure from Jeffrey conditionalization *without* my proposal, which also fails to satisfy that criterion.

That does not mean that my proposal is without cost. Any complete theory of perceptual learning that employs Jeffrey conditionalization to determine new beliefs from old beliefs and a weighted partition will require a second rule for determining partitions from experience (possibly together with old beliefs). The explanatory work to be done by the complete theory of perceptual learning will be divided between these two rules, and the more of this work that Jeffrey conditionalization can do the better supported it will be.

We're left, then, with Weisberg's first objection: that my proposal involves a loss of explanatory power. In this he is completely correct. It is unwelcome news that the Bayesian is unable to model the introduction of a negative correlation between an exogenously revised proposition and its underminers. He's also correct that the input partitions will need to be more complicated than those in my examples from §2.4, and so the auxiliary theory bridging the gap between experience and input partition will be more complex than the Bayesian might have initially supposed.

These are real objections to my proposal, and the best that can be done in response is to mitigate their badness. Two considerations to that effect. First, though the input partitions required by my proposal will involve a significant number of originating propositions, that number is dwarfed by the number of propositions that are not involved in it. Though the formal model will be unable to explain the introduced negative correlation between perceptually justified beliefs and their potential underminers, it will be able to explain how *those* changes ought to affect the agent's credences in all other propositions and hence to determine a posterior credence function. Even in its reduced state the explanatory power of the Bayesian formalism is quite robust. Second, as I argue below, Bayesians are already committed to a limitation upon starting credence functions that's closely analogous to this limitation upon input partitions, and it's unclear why the one constraint should be considered more problematic that the other. Hence it's unclear why Weisberg's objection to my proposal doesn't generalize into a broader indictment of Bayesianism.

As noted, Probabilism ensures that certain evidential relations will be encoded in any permissible credence function. For example, it ensures that any evidence that makes it rationally permissible to set $P_{new}(A)$ to .7 also makes it rationally permissible to set $P_{new}(\neg A)$ to .3, and prohibits setting $P_{new}(\neg A \& B)$ any higher than that. But not all intuitively mandatory evidential relations — those to which all rational agents are obliged to conform — are encoded by Probabilism, and hence many probabilistically coherent credence functions are intuitively impermissible. Famously, Probabilism fails to ensure that the observation of lots of green emeralds and no non-green ones supports

$(H_1)$ *all emeralds are green* more than it supports $(H_2)$ *all emeralds are grue.*[18] Because both $H_1$ and $H_2$ entail $E =$ *all observed emeralds are green*, conditionalizing on $E$ will increase (or leave the same) my confidence in both of them, and yet intuitively my posterior credence in $H_1$ should be much higher than that of $H_2$. According to the Bayesian, that means that before acquiring evidence $E$ it must be the case that $P_{old}(H_1\&E) > P_{old}(H_2\&E)$. In other words, if we wish to ensure that conditionalization determines a rationally permissible credence function from an update on $E$ the we must constrain our prior credence functions in ways that go well beyond Probabilism.

In many cases this phenomenon appears innocuous, as when an agent starts out thinking that $P_{start}(H_1\&E) \leq P_{start}(H_2\&E)$ and then adopts the desired inequality after acquiring new evidence and updating in the normal way. But this merely pushes the bump in the rug. Take $E^*$ to be the conjunction of $E$ and all of the other evidence that the agent has acquired to $t$. In that case a necessary and sufficient condition for the agent holding that $P_t(H_1) > P_t(H_2)$ is that their starting credence function $P_{start}(\cdot)$ be such that $P_{start}(H_1\&E^*) > P_{start}(H_2\&E^*)$.[19]

The narrow point is that if the Bayesian is to regard inductive inference as more epistemically respectable than counter-induction or non-induction, they'll need to go beyond mere Probabilism and impose further constraints

[18] See Goodman [1946] and [1983, p. 72-83].

[19] For Classical Bayesianism at least – the possible non-commutativity of Jeffrey Bayesianism makes that case less straightforward. See Domotor [1980].

upon starting credence functions. The broader point is this: for any $E$ and $H$ such that $E \nvDash H$ and $H \nvDash E$, ensuring that $E$ supports $H$ more than some competing hypothesis depends crucially on the choice of starting credence function. We have lots of intuitions about evidential relations that go beyond deductive entailment (e.g. the intuition that induction is preferable to counter-induction), and in order to require of agents that they satisfy those intuitions we have to constrain their starting credence functions. The Bayesian formalism (= Probabilism + Conditionalization) does not impose those restrictions, and hence additional constraints on starting credence functions are needed in order to ensure that their prior credence functions are rationally permissible, which are themselves required in order for Conditionalization to determine a rationally permissible posterior credence function given some permissible exogenous revision.

For the Bayesian, there are obvious parallels between what's required by Goodman's New Riddle and what I'm proposing in response to Weisberg's puzzle: just as the former requires a constraint upon rationally permissible starting credence functions, the latter requires a constraint upon exogenous revisions. Ideally, both of those constraints would be imposed by the formalism itself, but in both cases that's proven not to be the case. If we assume that Weisberg is objecting to proposals like mine, rather than to Bayesianism in general, then the problem can't simply be with the existence of intuitively compelling constraints upon the formalism for which we have no widely accepted formal theory; we have no such theory for distinguishing 'projectable' predicates like *green* from 'unprojectable' ones like *grue*, either. Presumably, then, the objection must be either (i) that such constraints are more objectionable at the exogenous revision side of the model than at the starting credence function side, or (ii) to some other feature of undermining defeat that distinguishes it from broader inductive practice, and in virtue of which my proposal is the more problematic. (i) seems arbitrary, and (ii) is not forthcoming. Seen in this light it's unclear how my proposal presents any special problem for the Bayesian that isn't closely analogous to a problem that they already have, and hence it's unclear how Weisberg is objecting to my proposal in particular rather than to Bayesianism in general.

There's one last objection that I'd like to consider. Weisberg [2015, 129] considers a response a bit like mine, which he characterizes as the claim that Jeffrey Conditionalization doesn't 'apply' in cases of perpetual undermining.[20] The thought here seems to be rooted in the late career Richard Jeffrey's somewhat unorthodox views about the motivations for Conditionalization. One prominent view among Bayesians is that agents ought to conditionalize because failure to do so leads to the sort of pragmatic defeat illustrated by the Lewis/ Teller dynamic Dutch book argument. (Teller [1973]) Jeffrey thinks that such considerations are beside the point,[21] and conditionalization is mo-

[20]See Wagner [2013] for a defense of this view.

[21]Interestingly, Jeffrey [2004] motivates Total Probability with a Dutch Book argument (§1.4) and then goes on to motivate Jeffrey conditionalization by appeal to Total Probability (§3.2). Hence there's a sense in which he *does* rely on considerations of pragmatic defeat to motivate conditionalization, but only because those pragmatic considerations motivate Probabilism.

tivated — when it is motivated — by considerations of coherence alone. The Total Probability theorem follows from the probability axioms plus the definition of conditional probability:

**Total Probability** $P_{new}(A) = \sum_i P_{new}(A \mid B_i) P_{new}(B_i)$

When the transition from an agent's old credences to her new ones is rigid on some $B_i$, $P_{new}(A \mid B_i) = P_{old}(A \mid B_i)$. Hence in such cases, by simple substitution on Total Probability we get:

**Jeffrey Conditionalization** $P_{new}(A) = \sum_i P_{old}(A \mid B_i) P_{new}(B_i)$

The upshot is that concerns of synchronic coherence alone require that we (Jeffrey) conditionalize upon our new evidence any time Rigidity holds. On this way of seeing things, Rigidity is a precondition that must be satisfied in order for Jeffrey Conditionalization to be applicable at all, rather than a feature of every case of perceptual learning that must be accommodated by all Bayesians (see footnote 7). That just leaves us with the following question: when is this precondition satisfied? Not always, says Jeffrey. And therein lies a possible answer to the puzzle: perhaps cases involving undermining defeaters are cases in which Rigidity does not hold, and hence they are cases in which Jeffrey conditionalization is unmotivated and inappropriate.

To this Weisberg very reasonably objects that perceptual justification is nearly always vulnerable to undermining defeat, and hence if Jeffrey conditionalization is inapplicable in cases involving the possibility of underminers, then it's inapplicable in nearly every case of perceptual learning.

Weisberg is no doubt correct about the near ubiquity of potential underminers for perceptual experience, and so if conditionalization is to be rejected in all such cases, then rational agents won't be doing much conditionalizing. But while this might be a serious problem for some other proposals, it's no objection to mine (to be clear: Weisberg never says that it is). On my proposal, Conditionalization applies in every case of perceptual learning. Underminable perceptual learning requires changes to conditional probabilities, changes that cannot be achieved endogenously through a rigid updating rule like Conditionalization. I've proposed that any time the probability of some proposition conditional on an originating proposition needs to change, that this change occur exogenously rather than via Conditionalization. This is important because exogenous credence revisions are not constrained by Rigidity[22] and hence need not preserve independence. But once all such changes are encoded into the partition, the rigidity of Conditionalization is completely unproblematic. Jeffrey conditionalization then 'applies' to the partitions that are determined by these (non-Rigid) exogenous revisions, and in this regard it's just like every

[22] It's not that exogenous revisions are anti-rigid, in the sense that they provide counterexamples to Rigidity, i.e. cases involving updates on a partition $\{B_i\}$ with element $B_i$ such that $P_{new}(A|B_i) \neq P_{old}(A|B_i)$; that's just confused. The inputs to an exogenous revision include experiences, so they're not just partitions, and hence the antecedent of the Rigidity conditional is always false in cases of exogenous revision. For that reason it's more precise to say that exogenous revisions *are* rigid, but only trivially so. The essential point is simply that this 'trivial rigidity' does not preserve independence: there is no analogue of the RIP principle for exogenous credence revisions.

other version of Bayesianism.[23,24]

## 2.6 Conclusion

The introduction of a negative correlation is an essential aspect of acquiring new information that is itself vulnerable to undermining defeat. Weisberg's puzzle is important because it illustrates that Bayesians can't model this effect in any straightforward way. Weisberg himself concludes that this is a reason to reject subjective Bayesianism. I have argued that this conclusion is too strong – the lesson instead is that Bayesians should reduce their explanatory ambitions, moving problematic aspects of undermining defeat off-model. This move is appealing for several reasons. First, restores the consistency of the Bayesian formalism with our intuitions about undermining defeat. Second, the Bayesian account of perceptual learning has always presupposed that some credences will be revised exogenously, revisions that to not proceed via conditionalization, and so my proposal represents only an incremental increase to an already existing aspect of the Bayesian theory rather than a new, dramatic departure. Third, while Conditionalization is rigid, Bayesian perceptual

[23] Thanks to an anonymous referee for call to my attention this aspect of my proposal.

[24] It's not that exogenous revisions are anti-rigid, in the sense that they provide counterexamples to Rigidity, i.e. cases involving updates on a partition $\{B_i\}$ with element $B_i$ such that $P_{new}(A|B_i) \neq P_{old}(A|B_i)$; that's just confused. The inputs to an exogenous revision include experiences, so they're not just partitions, and hence the antecedent of the Rigidity conditional is always false in cases of exogenous revision. For that reason it's more precise to say that exogenous revisions *are* rigid, but only trivially so. The essential point is simply that this 'trivial rigidity' does not preserve independence: there is no analogue of the RIP principle for exogenous credence revisions.

learning is not: since both Classical and Jeffrey Bayesians are committed to exogenous revisions that change the ratio of the probability of conjunctions to the probability of their conjuncts, it's inevitable that conditional probabilities themselves will change exogenously. So again, what I'm proposing isn't a great departure from the pre-Weisberg status quo. Fourth, my proposal doesn't involve commitment to any cases in which conditionalization doesn't 'apply'. Fifth, and finally, there's a long tradition of Bayesians imposing extra-formal constraints upon their theory in order to deal with counter-intuitive consequences of the minimal Probabilism + Conditionalization account, as they do in response to Goodman's New Riddle.

# Chapter 3

# Holistic Conditionalization and Underminable Perceptual Learning

## 3.1 Introductory Matters

### 3.1.1 The Incompleteness of Bayesianism

What do we expect from a theory of perceptual learning? Here's a plausible thought: a complete theory of the epistemology of perceptual learning would specify how having some particular experience affects the beliefs of rational agents. More carefully, it would provide a rule of the form: $(P_{old}(\cdot), \mathcal{E}) \mapsto P_{new}(\cdot)$, where $P_{old}(\cdot)$ is the agent's prior credence function, $\mathcal{E}$ is the experience, and $P_{new}(\cdot)$ is the posterior credence function that an agent with $P_{old}(\cdot)$ ought to adopt upon having experience $\mathcal{E}$. Bayesian Conditionalization (specifically: Jeffrey Conditionalization), on the other hand, specifies how a change in a handful of attitudes ought to affect an agent's other attitudes: it's a rule of the form $(P_{old}(\cdot), \{< e_i, \omega_i >\}) \mapsto P_{new}(\cdot)$, where the $e_i$ are propositions that partition the agent's probability space and the $\omega_i$ are the weights of the $e_i$. Experiences are not sets of weighted propositions — $\mathcal{E}$ and $\{< e_i, \omega_i >\}$ are very different sorts of things — so Bayesian Conditionalization is not a complete theory of the epistemology of perceptual learning.

In what sense, then, is Bayesianism a theory of perceptual learning?

The idea seems to be that the initial or immediate effect of experience $\mathcal{E}$ is to spark revisions to a small number of credences, and that these revision lead to other revisions that are mediated by a quasi-inferential process. In Bayesian terms, the immediate effect is to provide weighted partition $\{< e_i, \omega_i >\}$, which in turn combines with the agent's prior credence function to produce the agent's posterior credence function.[1] Bayesianism is then a theory of the mediate effects of experience: it takes the immediate effects of $\mathcal{E}$ — weighted partition $\{< e_i, \omega_i >\}$ — as input and via Conditionalization it produces a posterior credence function $P_{new}(\cdot)$ as output.

In what follows it will be important to clearly distinguish the credence revisions that proceed via Conditionalization from those that provide the weighted partition to be conditionalized upon, so for convenience I'll introduce some terminology. The effects of experience that are not modeled or regulated by Conditionalization I'll call *exogenous* revisions (as in *exogenous to the model*), and the revisions that are modeled and so proceed by Conditionalization I'll call *endogenous* revisions.[2] Hence the general Bayesian picture of perceptual learning is a two-stage process that involves both types of revision:

[1] I don't mean to commit myself to any particular account of *which* propositions are immediately affected by experience; for our purposes they are characterized simply as those propositions whose revision does not proceed via Conditionalization. This become important below, when I argue that the partitions that Bayesians should conditionalize upon are quite complex.

[2] This terminology originates in Howson and Urbach [1993].

$$\underbrace{(P_{old}(\cdot), \mathcal{E}) \mapsto \overbrace{(P_{old}(\cdot), \{< e_i, \omega_i >\})}^{\text{Endogenous revision}}}_{\text{Exogenous revision}} \mapsto P_{new}(\cdot)$$

We are now in a position to say more carefully the sense in which Bayesianism is an *incomplete* theory of perceptual learning. Whether the posterior credence function adopted is rationally appropriate for an agent with prior credence function $P_{old}(\cdot)$ who has experience $\mathcal{E}$, i.e. whether the posterior credence function adopted is equal to $P_{new}(\cdot)$, will depend not only upon the adequacy of Jeffrey Conditionalization, but upon whether conditionalizing on $\{< e_i, \omega_i >\}$ was the appropriate response to $\mathcal{E}$. Bayesianism doesn't regulate those revisions, so Bayesianism doesn't determine whether the posterior credence function adopted is appropriate for an agent with $P_{old}(\cdot)$ who has experience $\mathcal{E}$.

Familiar objections to Bayesianism pick up on putative problems *inside* the model, problems that arise either from the demand for probabilistically coherent credences (e.g. the problem of logical omniscience) or from the demand that all modeled credence revisions proceed via Conditionalization (e.g. the problem of old evidence, the problem of invincible certainty). Importantly, these objections arise from Bayesian constraints upon rational sets of *attitudes towards propositions*. One more recent line of criticism contends that the model imposes undesirable limitations upon the off-model or exogenous credence revisions that result directly from experience. In particular, the Bayesian formalism seems to combine awkwardly with the putatively holistic nature of perceptual confirmation.

### 3.1.2 Confirmation Holism

I understand Holism about perceptual confirmation as the thesis that the appropriate immediate response to experience is determined not simply by the experience, but by also in part by the agent's background beliefs. In other words, it's possible that a pair of exogenous revisions to be such that $(P_{old}(\cdot), \mathcal{E}) \mapsto (\{< e_i, \omega_i >\})$ and $(P'_{old}(\cdot), \mathcal{E}) \mapsto (\{< e_j, \omega_j >\})$, (where $i \neq j$). In this paper I'm not so concerned with whether confirmation holism is true, though for the record I think that it is. My focus is instead upon the consistency of Bayesianism and holism about perceptual confirmation.

Bayesians are committed to holism when it comes to the endogenous credence revisions that proceed via Conditionalization. (Strict) Bayesian Conditionalization requires that when I obtain some propositional evidence $A$ I must reset my credence in any other proposition $B$ to: $P_{old}(B \mid A)$. These conditional probabilities are standardly[3] defined in terms of what the agent believes about the correlation between the relevant propositions at the moment when she obtains propositional evidence $A$: if she believes that $A$ and $B$ are positively correlated then she'll think that $P_{old}(B \mid A) > P_{old}(B)$, and so when she increases her credence in $A$ and conditionalizes she'll end up increasing her credence in $B$. Because Bayesians generally think that the evidential significance of propositional evidence $A$ is partially determined by background

[3]But not universally: see Hájek [2003] and Popper [1959].

beliefs about the correlation between $A$ and $B$, they also think that it's possible that:

$$(P_{old}(\cdot), A) \mapsto P_{new}(B) = high$$

but

$$(P'_{old}(\cdot), A) \mapsto P'_{new}(B) = low$$

Hence Bayesians are committed to holism about *propositional* evidence just as our Confirmation Holists are committed to holism about *perceptual* evidence.

The Bayesian formalism entails very few constraints upon the exogenous effects of experience and hence Bayesians are mostly free to accept or reject holism about perceptual confirmation. One partial exception comes in the form of *Classical* Bayesians who accept *Strict* Conditionalization. Strict Conditionalization takes as evidence only propositional certainties, so holistic considerations can't determine the degree of confirmation that my evidence propositions receive exogenously: if I'm going to strictly conditionalize upon A, then A must be maximally confirmed.[4] Nonetheless it's possible that holistic considerations will help to determine whether my experience confirms $A$ or some other proposition.

*Jeffrey* Bayesians[5] relax the strictness of Strict Conditionalization, allowing updates on propositions with credences less than 1 through *Jeffrey*

[4]Formally: for any $P_{old}(\cdot)$ and $P'(\cdot)$, $P_A(A) = P'_A(A) = 1$.

[5]For our purposes a 'Jeffrey Bayesian' is any Bayesian who accepts Richard Jeffrey's generalization of Classical Conditionalization, and hence they need not be committed to any other aspect of Richard Jeffrey's programme.

Conditionalization:[6]

**Jeffrey Conditionalization:** $P_{new}(\cdot) = \sum_i P_{old}(. \mid e_i) \cdot \omega_i$

Later it will be important to be very clear about how Jeffrey Conditionalization works, but I'll put that off until it becomes necessary.

Jeffrey Bayesians can accept holistic effects to their exogenous revisions in response to experience, and given the broader Bayesian sympathy for confirmation holism it would be somewhat perverse for them to reject it. One holistic effect will be of particular importance in this paper: the vulnerability of perceptual justification to undermining defeat. When I have a visual experience as of the redness of the hat and become justified in believing *the hat is red*, that justification is undermined when I learn that I've been hallucinating all day: it's not that I have some reason to believe that the hat is *not* red — I haven't obtained an *opposing* defeater — it's that I've obtained some reason to doubt that my perceptual experience rationally supports my belief.[7]

3.1.3

### 3.1.3 Weisberg's puzzle

Jonathan Weisberg argues that Jeffrey Conditionalization is inconsistent with common intuitions about a specific type of holistic effect: undermining defeat. The intuition is that a perceptual experience as of a red hat doesn't

[6] Where $\omega_i = P_{new}(e_i)$.

[7] For more on undermining defeat and its relation to opposing defeat see [Pollock and Cruz, 1999, 196-7].

just affect my beliefs about the color of the hat or about my own experiences, it also affects what constitutes a defeater for those beliefs. Before I have my experience as of the hat I would regard *I'm hallucinating* as evidentially independent of *the hat is red* — neither confirming nor disconfirming it — an independence that is expressed formally as $P_{old}(red \mid hallucinating) = P_{old}(red)$. After my experience as of the hat's redness I become much more confident that the hat is in fact red, an increase that's based in my experience, but at this point I no longer think that those propositions are independent. After all, my high confidence is based on the experience, and learning that I was hallucinating is a good reason to doubt that my experience is an appropriate basis for my belief. Hence I now believe that $P_{new}(red \mid hallucinating) < P_{new}(red)$. But that change in my conditional probabilities is impossible, Weisberg argues, because Jeffrey Conditionalization is 'rigid' with respect to the elements of the update partition[8]

**Rigidity:** For any endogenously revised $A$ and any exogenously revised $e_i$,

$$P_{old}(A \mid e_i) = P_{new}(A \mid e_i)$$

[8]Proof: Let $e_1$ be one the $e_i \in \{e_i\}$. The $e_i$ are pairwise inconsistent, so for any $e_j \in \{e_i\}$ such that $e_j \neq e_1$, $P_{old}(A\&e_1 \mid e_j) = 0$, meaning that, trivially, $P_{old}(A\&e_1 \mid e_j) \cdot P_{new}(e_j) = 0$. By Jeffrey Conditionalization, $P_{new}(A\&e_1) = \sum_i P_{old}(A\&e_1 \mid e_i) \cdot P_{new}(e_i)$, but we've just seen that when a partition element other than $e_1$ is taken as the value of $e_i$, the value of the resulting summand is 0. It follows that $P_{new}(A\&e_1) = P_{old}(A\&e_1 \mid e_1) \cdot P_{new}(e_1)$. A bit of algebra turns this into ${}^{P_{new}(A\&e_1)}/_{P_{new}(e_1)} = P_{old}(A\&e_1 \mid e_1)$, and the right side of the equation simplifies to $P_{old}(A \mid e_1)$. Finally, by the Ratio Analysis of conditional probability, ${}^{P_{new}(A\&e_1)}/_{P_{new}(e_1)} = P_{new}(A \mid e_1)$. Hence for any partition element $e_1$ and any proposition $A$ whose credence is determined by conditionalizing on weighted partition $\{e_i\}, P_{old}(A \mid e_1) = P_{new}(A \mid e_1)$, i.e. Jeffrey Conditionalization is rigid with respect to the elements of update partition.

Rigidity says that updating on a partition with element $e_i$ can't change my credence in any other proposition conditional on $e_i$. That's problematic because rigidity is independence preserving (RIP):[9]

**RIP:** If the transition from $P_{old}(\cdot)$ to $P_{new}(\cdot)$ is rigid on the partition $\{e\}$ and $P_{old}(A \mid e_i) = P_{old}(A)$ for all $e_i \in \{e\}$, then $P_{new}(A \mid e_i) = P_{new}(A)$ for every $e_i \in \{e\}$

Hence if *the hat is red* and *I'm hallucinating* are evidentially independent, and then I conditionalize on a partition including *the hat is red* as an element, then those propositions must remain independent. That's inconsistent with the compelling story that I just told about the functioning of undermining defeaters, and so Weisberg concludes that Bayesian Conditionalization should be rejected.

### 3.1.4 Gallow's Two Claims

Elsewhere I've argued that Jeffrey Conditionalization is consistent with perceptual learning that's vulnerable to undermining defeat, an argument that I summarize in section 3.2 below. An alternative approach has been advocated by Dmitri Gallow, who holds that Weisberg's puzzle provides grounds for

[9]Proof: By the total probability theorem, $P_{new}(A) = \sum_i P_{new}(A \mid e_i) \cdot P_{new}(e_i)$. The rigidity of the transition ensures that $P_{old}(A \mid e_i) = P_{new}(A \mid e_i)$, so $P_{new}(A) = \sum_i P_{old}(A \mid e_i) \cdot P_{new}(e_i)$. The prior independence of $A$ and each $e_i$ means that $P_{old}(A \mid e_i) = P_{old}(A)$, so this becomes $P_{new}(A) = \sum_i P_{old}(A) \cdot P_{new}(e_i)$. The $e_i$ form a partition, so the $P_{new}(e_i)$ sum to 1, which means that $P_{new}(A) = P_{old}(A) \cdot 1 = P_{old}(A)$. Finally, by prior independence, $P_{old}(A) = P_{old}(A \mid e_i)$, which by rigidity is equal to $P_{new}(A \mid e_i)$, so $P_{new}(A) = P_{new}(A \mid e_i)$, so independence is preserved.

rejecting Jeffrey Conditionalization in favor of an alternative update rule that he calls ‘Holistic Conditionalization’:

> [Weisberg’s puzzle shows that] neither Conditionalization nor Jeffrey Conditionalization. . . is capable of accommodating the confirmation holist’s claim that beliefs acquired directly from experience can suffer undermining defeat. I will diagnose this failure as stemming from the fact that neither of these rules give any advice about how to rationally respond to experiences in which our evidence is theory-dependent, and I will propose a novel updating procedure which does tell us how to respond to these experiences. [Gallow, 2014, 1-2]

My purpose in this essay is to defend the superiority of my solution to Wiesberg’s puzzle against Gallow’s, a purpose that I pursue by refuting the two claims that Gallow makes in the above passage: that Jeffrey Conditionalization cannot accommodate perceptual confirmation that’s vulnerable to undermining defeat, and that the alternative ‘Holistic Conditionalization’ and ‘Holistic Conditionalization*’ rules that he proposes are superior to Jeffrey Conditionalization.

## 3.2 Jeffrey Conditionalization and Undermining Defeat

In this section I argue contra Gallow that Jeffery Conditionalization is consistent with perceptual learning that is vulnerable to undermining defeat. It’s not that Jeffrey Conditionalization isn’t rigid, or that rigidity doesn’t preserve independence; it is, and it does. But the independence that Rigidity preserves is between *each element of the partition* and every other proposition; no other independence relations are preserved by rigidity.[10] As a result, the construction of a rigidity puzzle requires careful attention to the which propositions are selected as the elements of the input partition: if the independence of *the hat is red* and *I'm hallucinating* is to be preserved (as the puzzle requires), then one of those propositions must be an element of the partition. But the Bayesian formalism is consistent with a wide range of input partitions, and as a result the input partitions required by Weisberg's puzzle are optional for the Jeffrey Conditionalizer.

So how are the elements of the input partition selected? One appealing thought is that the elements of the partition are the propositions directly or immediately affected by the experience. For example, a hat-like experience might immediately affect *the hat is red* and *the hat is dirty* and no other propositions, in which case the input partition would consist of those two propositions as elements. Clearly the propositions directly affected by experience should be among those exogenously revised, and hence they must appear in the input partition, in some sense of 'appear in'. But there is good reason to doubt that they must always appear as the *elements* of that partition, a reason that has nothing to do with undermining or with Weisberg's puzzle.

[10]Too strong: any propositions with a credence of 1 credence 1 (i) is independent of every other proposition, and (ii) cannot have its credence revised downward, and and hence by (i) will always be independent of every other proposition. Trivially, then, the independence of every credence 1 proposition with every other proposition is preserved across every Conditionalization.

The problem is that the elements of a partition must be pairwise inconsistent and exhaustive of the probability space, and this pair is likely to be neither.[11] Jeffrey Conditionalization takes only partitions as arguments, and hence this would be a case in which the agent is unable to update.

Richard Jeffrey was familiar with this potential problem. In response he proposed that, in many cases at least, input partitions must be more complicated than a mere set of immediately affected propositions. His suggestion is that the partitions contain a set of conjunctions, each conjunct of which is either one of our directly affected propositions or its negation, with every directly affected proposition or its negation appearing exactly once in each conjunction. Hence upon having an experience as of the dirty red hat, instead of taking *red* and *dirty* as the elements of my partition (which typically won't actually result in a partition) I should conditionalize upon a partition with elements $red$ & $dirty, red$ & $\neg dirty, \neg red$ & $dirty$, and $\neg red$ & $\neg dirty$.

Jeffrey's proposal allows the propositions immediately affected by experience to be included in the input partition without including them as elements of that partition. This in turn allows their posterior credences to be determined exogenously, while at the same time enabling conditionalization upon

[11] Why just 'likely' to be neither? What's important is that the elements of the partition be exclusive and exhaustive relative to the probability space of the relevant agent, not exclusive and exhaustive of every possible probability space. To illustrate with an example, *the hat is red* and *the hat is blue* are logically consistent, but relative to the probability space of an agent with normal beliefs about color-exclusion they will be exclusive. Similarly, those propositions will not in every case be exhaustive, but they will exhaust the probability space of an agent who is certain that the hat is either red or blue.

an element composed of propositions that do not straightforwardly form a partition.

Jeffrey's proposal also suggests a solution to Weisberg's puzzle. Rigidity prevents the introduction of a negative correlation between the elements of a partition and any proposition that isn't an element of the partition. Taking the elements of our partitions to be conjunctions doesn't change that: Conditionalization still cannot introduce a correlation between one of our elements — one of the conjunctions — and some other proposition. What it can do, however, is to introduce a correlation between the *conjuncts* of one of those conjunctive elements.

Here's why: for any $A$ and $B$, $P_{new}(A) = P_{new}(A\&B) + P_{new}(A\&\neg B)$, so the posterior weights of conjunctions $A\&B$ and $A\&\neg B$ together determine the posterior weight of $A$ and (trivially) the posterior weight of $A\&B$. By the definition of conditional probability, $P_{new}(A \mid B) = P_{new}(A\&B)/P_{new}(B)$, and hence the weights of the conjunctions determine the value of $P_{new}(A \mid B)$. $A$ and $B$ are independent iff $P_{new}(A \mid B) = P_{new}(A)$, and hence their independence (or lack thereof) is completely determined by the posterior weights of the conjunctive elements of the partition, weights that are themselves assigned exogenously. The upshot is that it's possible to introduce the desired correlation between $A$ and $B$ by exogenously re-weighting the elements of the partition.

To illustrate how this might actually work as a response to Weisberg's puzzle, suppose that I start out thinking that *the hat is red* and *I'm halluci-*

*nating* are independent: $P_{old}(red \mid hallucinating) = P_{old}(red) = \nicefrac{1}{2}$. Then I conditionalize on the following set of $e_i/\omega_i$ pairs:

$$\{B_i\} = \begin{cases} < red \ \& \ hallucinating, \nicefrac{1}{10} > \\ < red \ \& \ \neg hallucinating, \nicefrac{7}{10} > \\ < \neg red \ \& \ hallucinating, \nicefrac{1}{10} > \\ < \neg red \ \& \ \neg hallucinating, \nicefrac{1}{10} > \end{cases}$$

My posterior credence function $P_{new}(\cdot)$ will now be such that:

$$P_{new}(red \mid hallucinating) = \frac{P_{new}(red \ \& \ hallucinating)}{P_{new}(hallucinating)} = \frac{\nicefrac{1}{10}}{\nicefrac{1}{5}} = \nicefrac{1}{2}$$

but

$$P_{new}(red) = P_{new}(red \,\&\, hallucinating) + P_{new}(red \,\&\, \neg hallucinating) = \nicefrac{4}{5}$$

which is important because now:

$$P_{new}(red) > P_{new}(red \mid hallucinating)$$

In other words, *the hat is red* and *I'm hallucinating* started out independent and ended up negatively correlated: were I subsequently to become certain that I was hallucinating when I had my experience as of the redness of the hat I would reduce my credence in *the hat is red* back to $\nicefrac{1}{2}$.

Recall that the putatively problematic cases of perceptual learning vulnerable to undermining defeat are ones in which the rational response to experience $\mathcal{E}$ is (i) to increase my confidence in some proposition $e$ and (ii) to introduce a negative correlation between $e$ and some undermining defeater $u$. The rigidity of Jeffrey Conditionalization means that if $e$ is an element of the input partition then (ii) is impossible, but it should now be clear that conditionalizing on a partition with elements $e\&u, e\&\neg u, \neg e\&u$, and $\neg e\&\neg u$ is capable of achieving both (i) and (ii).

Doesn't the rigidity of Conditionalization prevent this sort of move? No. Above I distinguished two types of credence revisions: the endogenous revisions that proceed via Jeffrey Conditionalization and hence are regulated by it, and the exogenous revisions that determine the propositional evidence to be conditionalized upon (i.e. the input partition). Since only the endogenous revisions proceed via Conditionalization, only endogenous revisions are constrained by the rigidity of that rule. The elements of input partitions and the weights of those elements are the result of exogenous revisions, and so are not constrained by the rigidity of Conditionalization.

Though this approach is formally adequate, is not without cost. Conjunctive elements are not the 'direct' or 'immediate' effects of experience in any intuitive sense, and hence my response to Weisberg's puzzle requires that we reject the picture of Bayesianism as a theory of all of the indirect epistemic effects of experience; far more will have to be left out. In particular, much of what's interesting about undermining defeat will be moved outside of the model (i.e. much of it will be unregulated by Conditionalization) and hence will be left unexplained.[12]

I motivate this move in other work. [Manuscript] My purpose in this

[12]For an objection to this sort of move see Christensen [1992].

essay is to argue that Jeffrey Conditionalization is a superior updating rule to Holistic Conditionalization and to Holistic Conditionalization*, and as it turns out the independent motivations for Jeffrey Conditionalization aren't terribly important to that task. My purpose in the present section has been to rebut Gallow's claim that Jeffrey Conditionalization is not 'capable of accommodating the confirmation holist's claim that beliefs acquired directly from experience can suffer undermining defeat.' [Gallow, 2014, 1-2]. It should now be obvious that this claim is false: Jeffrey Conditionalization is perfectly consistent with perceptual learning that's vulnerable to undermining defeat, on the condition that both the propositions 'acquired directly from experience' and their potential underminers are taken as conjuncts of the conjunctive elements of the input partition.

## 3.3 Holistic Conditionalization

In the previous section I argued that Jeffrey Conditionalization is perfectly consistent with the phenomenon of undermining defeat, and hence Gallow's first claim is false. Nonetheless his proposed solution to Weisberg's puzzle — the rejection of Jeffrey Conditionalization in favor of Holistic Conditionalization — might be preferable for other reasons. In this section I describe Gallow's first alternative proposal with particular attention to how it relates to Jeffrey Conditionalization, before moving on in the next section to arguments for the superiority of the latter over the former.

I've described confirmation holism as the very general thesis that the evidential significance of experience is partially determined by the agent's background beliefs: that experience $\mathcal{E}$ might produce one weighted partition for an agent with $P_{old}(\cdot)$ and another for an agent with $P'_{old}(\cdot)$. This very general thesis can be made more precise in a number of ways. According to one very strong version of holism there's simply nothing more to be said about how $P_{old}(\cdot)$ contributes to the determination of the partition: the contribution is made by the agent's doxastic state taken as a whole, rather than individual contributions made by attitudes toward individual propositions. But there's reason to believe that more *can* be said. Consider again the case of $\mathcal{E}$, my visual experience as of the red hat. It's plausible that my beliefs about current lighting conditions and about the reliability of my own perceptual faculties play a role in determining the epistemic significance of $\mathcal{E}$. It's far less plausible that my beliefs about the atomic number of copper or about the capital of Peru have any such role to play.

For the *naïve* Jeffrey Conditionalizer — one who thinks that the input partition is the set of propositions directly affected by the experienc — it doesn't matter what aspects of $P_{old}(\cdot)$ combine with $\mathcal{E}$ to determine the input partition, whether it's the function taken as a whole, or just some subset of the credences determined by it. Once the input partition is determined exogenously the holistic effects of those prior credences can be ignored, as Conditionalization will determine the posterior credence function solely from the prior credence function and the input partition.

The Holistic Conditionalizer sees this as problematic. On their view, the evidential significance of experience depends upon the agent's background theories about what the world is like — e.g. *I'm the victim of a Cartesian demon*, or *My perceptual faculties are functioning normally* — and this dependence is essential to responding to Weisberg's puzzle. Background theories are propositions, and so they are assigned credences by my prior credence function $P_{old}(\cdot)$. Thus confirmation holism is true — $\mathcal{E}$ might produce one weighted partition for an agent with $P_{old}(\cdot)$ and another for an agent with $P'_{old}(\cdot)$ — because $P_{old}(\cdot)$ and $P'_{old}(\cdot)$ might assign different credences to the relevant background theories on which the epistemic significance of $\mathcal{E}$ depends.

According to the Holistic Conditionalizer, the problem with Jeffrey Conditionalization is that it's sensitive only to *the fact that* $\mathcal{E}$ produced the propositional evidence that it did, and it's not at all sensitive to *the reason why* $\mathcal{E}$ produced the evidence that it did. Since those dependence facts aren't reflected in the agent's prior credence function (how could they – they're not facts yet!), and since those dependence facts aren't represented in the updating procedure of the naïve Jeffrey Conditionalizer,[13] those dependence facts won't be reflected in the posterior credence function either. Finally, since reference to those facts is essential to any solution to Weisberg's puzzle (see section 3.3.1), the naïve Jeffrey Conditionalizer will be unable to solve the puzzle.

The general idea is simple: the propositional evidence generated by experience depends upon the agent's attitudes towards their background theo-

[13]Remember: the naïve Jeffrey Conditionalizer is *naïve* because they exclude those dependence relations from their input partitions.

ries, and since agents are not always certain which background theory is true, they are not always in a position to determine whether some proposition is evidence. What they are in a position to do, however, is to determine whether some proposition would be evidence, given the truth of a particular background theory.

For example, suppose that I'm not sure whether I'm the victim of a Cartesian demon or a Cartesian angel, but I'm sure that it's one or the other (and not both). If it's the demon then I can be sure that *my experiences are all misleading*; call this background theory $t_M$. But if I'm the beneficiary of a Cartesian angel then could be sure that *my experiences are perfectly veridical*; call that background theory $t_V$. If my experiences are all misleading then my experience as of the red hat produces propositional evidence *the hat is not red*, and if my experience is perfectly veridical then my evidence is *the hat is red*.

Because I'm not sure which theory is correct, I'm not sure what my propositional evidence would be once I've had experience $\mathcal{E}$, so I'm not sure how to update my credences in light of my experience. But since I'm sure that, if $t_V$ is true,[14] then my evidence is *the hat is red*, I can calculate what my posterior credences would be *if I had been sure that* $t_V$ *were true*. In that case I would be sure that $t_V$ is true (trivially) and I would have received *the hat is red* as my propositional evidence (becoming certain of it as well), and so I would be sure of their conjunction. I know what to do when I become

[14]That's a little misleading: it's not the truth of $t_V$ that determines my evidence, it's my beliefs about $t_V$ that matter.

certain of some proposition: I conditionalize. Hence even though I don't know which of my background theories is true, I know that if I had been certain of $t_V$, and then I had had experience $\mathcal{E}$, then it would have to be the case that:

$$P_{new}(\cdot) = P_{old}(\cdot \mid t_V \text{ \& } \textit{the hat is red})$$

For analogous reasons I'm in a position to calculate that, if I had been sure that $t_M$ were true, it would be the case that:

$$P_{new}(\cdot) = P_{old}(\cdot \mid t_M \text{ \& } \textit{the hat is not red})$$

Gallow proposes two very similar updating rules for translating this information into posterior credence functions. Both rules involve calculating $P_{new}(\cdot)$ as a weighted sum of $P_{old}(\cdot \mid t_i \& e_i)$, for each $t_i$/ $e_i$ pair, the only difference being the way that the summands are weighted. With the stipulating that the $t_i$ partition the probability space, the first rule is:

**Holistic Conditionalization:** $P_{new}(\cdot) = \sum_i P_{old}(\cdot \mid t_i \& e_i) \cdot P_{old}(t_i)$

This has the following result: for each conjunction $t_i \& e_i$, $P_{new}(t_i \& e_i) = P_{old}(t_i)$,[15] which ensures that for each $t_i$, $P_{new}(t_i) = P_{old}(t_i)$.[16] In other words,

[15] Proof: by Holistic Conditionalization, $P_{new}(t_1 \& e_1) = \sum_i P_{old}(t_1 \& e_1 \mid t_i \& e_i) \cdot P_{old}(t_i)$. One of the $t_i$ will be $t_1$ itself, and so one of the summands must be $P_{old}(t_1 \& e_1 \mid t_1 \& e_1) \cdot P_{old}(t_1) = P_{old}(t_1)$. The other summands are calculated using the other $t_i$, but those values will all be 0: since the background theories form a partition they must be pairwise inconsistent, so for every $t_i \neq t_1$, $P_{old}(t_1 \& e_1 \mid t_{i \neq 1} \& e_{i \neq 1}) \cdot P_{old}(t_{i \neq 1}) = 0$. The result is that $P_{new}(t_1 \& e_1)$ is equal to the sum of $P_{old}(t_1)$ and a bunch of 0's, so it's equal to $P_{old}(t_1)$.

[16] Proof: $P_{new}(t_i)$ can't be any lower than $P_{new}(t_i \& e_i)$, and in order to be higher there must be some $i' \neq i$ such that $P_{new}(t_i \mid t_{i'} \& e_{i'}) \geq 0$. But the $t_i$ form a partition, so that's impossible. That ensures that $P_{new}(t_i) = P_{new}(t_i \& e_i)$, and since $P_{new}(t_i \& e_i) = P_{old}(t_i)$ (see fn. 15) it follows that $P_{new}(t_i) = P_{old}(t_i)$.

according to Holistic Conditionalization, episodes of learning from experience can't affect credences in the agent's background theories. That's problematic in certain cases (see below), and so Gallow offers a generalization of Holistic Conditionalization on which revisions to the probabilities of background theories are accommodated. Where $\Delta_i$ is a quantity that re-weights each background theory $t_i$ in order to reflect the epistemic significance of $\mathcal{E}$ upon $t_i$,

**Holistic Conditionalization*:** $P_{new}(\cdot) = \sum_i P_{old}(\cdot \mid t_i \& e_i) \cdot P_{old}(t_i) \cdot \Delta_i$

### 3.3.1 Holistic Conditionalization and Weisberg's Puzzle

Before moving on let's look carefully at how Holistic Conditionalization (and by extension Holistic Conditionalization*) solves Weisberg's puzzle. Recall that the puzzle arises because experience has at least two distinct epistemic effects: it provides propositional evidence, and it introduces negative correlations between that propositional evidence and its potential undermining defeaters. The putative problem for Jeffrey Conditionalization is that although there is no barrier to incorporating newly acquired propositional evidence into the posterior credence function, the rigidity of that rule appears to make it impossible to introduce the necessary correlations between propositional evidence and its undermining defeaters. I have proposed that Jeffrey Conditionalizers respond to Weisberg's puzzle by conditionalizing upon conjunctions of the newly acquired propositional evidence and its potential undermining defeater. This solves the puzzle by introducing the needed correlation at the point at which the input partition is selected — the exogenous revision stage — which obviates the need to introduce that correlation via Conditionalization (which is impossible).

Holistic Conditionalization avoids the problem in essentially the same way. Any propositions that need to become correlated with the evidence propositions, including any potential undermining defeaters, are taken to be the background theories: the $t_i$.[17] After holistically conditionalizing, each $e_i$ becomes certain, conditional upon $t_i$,[18] and hence for each $t_i$ / $e_i$ pair, $P_{new}(e_i \mid t_i) = 1$. Assuming that $P_{new}(e_i)$ is less than 1, it follows that after conditionalizing, $e_i$ and $t_i$ will be positively correlated. The existence of this correlation will hold regardless of the relationship between $P_{old}(e_i \mid t_i)$ and $P_{old}(e_i)$,[19] and in particular it will hold even if according to my prior credence function $e_i$ and $t_i$ are independent of one another. Because a *positive* correlation has been established $e_i$ and $t_i$, a *negative* correlation has been established between $e_i$ and $\neg t_i$. That means that any subsequent increase in my confidence in $\neg t_i$ will result in a decrease in my confidence in $e_i$. In other words, $\neg t_i$ is now a defeater for $e_i$.[20]

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[17] In some cases the relevant background theories will fail to form a partition and so partitions will need to be constructed out of conjunctions of background theories. In such cases the theory/ evidence conjunctions input to Holistic Conditionalization will be of the form $t_1\&...\&t_N\&e$. This procedure will mirror the one that I described in section 3.2, with like effect. See [Gallow, 2014, 11, fn. 13].

[18] Proof: combining the results from fn. 15 and 16 yields $P_{new}(e_i\&t_i) = P_{new}(t_i)$, so $P_{new}(e_i\&t_i)/P_{new}(t_i) = 1$ (or undefined), so $P_{new}(e_i \mid t_i) = 1$ (or undefined).

[19] Assuming that $P_{old}(e_i\&t_i) > 0$.

[20] That's a bit too strong. It's possible that I'll decrease my confidence in $t_i$ because I've increased my confidence in competing background theory $t_j$, where $P_{old}(e_i \mid t_j) = 1$. In that

I'll illustrate how this works with an example. Recall the case above in which my background theories are *my experiences are perfectly veridical* (= $t_V$) and *my experiences are perfectly misleading* (= $t_M$). Upon having an experience as of a red hat, the truth of $t_V$ would produce propositional evidence *the hat is red*, but the truth of $t_M$ would produce propositional evidence *the hat is not red*. Holistic Conditionalization suggests that my posterior credence in *the hat is red* should be the sum of $P_{old}(red \,\&\, veridical) \cdot P_{old}(veridical)$ and $P_{old}(\neg red \,\&\, misleading) \cdot P_{old}(misleading)$, and that there should now be a perfect correlation between *red* and *veridical*, and also between $\neg$*red* and *misleading*. Hence if I were to become more confident that my experiences are misleading I'd thereby become more confident that the hat isn't red, i.e. *the hat is red* would suffer defeat. Represented visually:

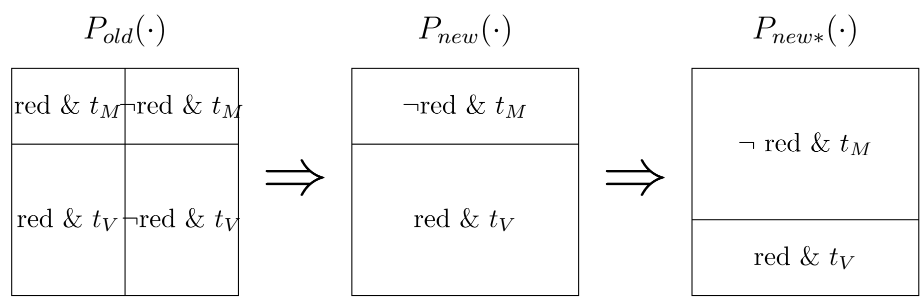


Figure 3.1: Visual representation of how Holistic Conditionalization solves Weisberg's puzzle.

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case my credence in $e_i$ won't change. Any decreased credence in $t_i$ will be accompanied by an increased credence in some other $t_k$, and in order for that shift to result in a decreased credence in $e_i$ it must be the case that $P_{new}(e_i \mid t_k) < 1$.

This diagram represents a case in which I start out with credence function $P_{old}(\cdot)$, on which $t_V$ and $t_M$ as equally probable, *the hat is red* and *the hat is not red* are equally probable, and the background theories are independent of the redness of the hat. After my experience as of the red hat I adopt credence function $P_{new}(\cdot)$, on which $t_V$ becomes perfectly correlated with *the hat is red* and $t_M$ becomes perfectly correlated with *the hat is not red*, but my unconditional credences in the background theories have not changed. The transition from $P_{new}(\cdot)$ to $P_{new*}(\cdot)$ is occasioned by my acquisition of an undercutting defeater for *the hat is red*, which increases my confidence in $t_M$ & $\neg red$ at the expense of $t_V$ & $red$.

Note that nothing about this story requires that my credence in the various background theories remain unchanged as a result of the learning episode. The only difference between Holistic Conditionalization and Holistic Conditionalization* is that the latter allows such changes in credence in background theory, and hence the response to Weisberg's puzzle will be the same for each.

## 3.4 Holistic Conditionalization and Jeffrey Conditionalization

Gallow claims that the lesson of Weisberg's puzzle is that Jeffrey Conditionalization is inconsistent with important aspects of undermining defeat, and hence that Jeffrey Conditionalization should be rejected in favor of Holistic Conditionalization. We've now seen that this is false: both Jeffrey Conditionalization and Holistic Conditionalization offer technically adequate solutions to Weisberg's puzzle, and hence the puzzle itself offers no reason to prefer one rule to the other. In this section I argue on independent grounds that Jeffrey Conditionalization should be preferred.

Astute readers will have noticed that Jeffrey Conditionalization and Holistic Conditionalization are very similar rules. I begin by clarifying the relationship between the two, demonstrating that Holistic Conditionalization is a special case of Jeffrey Conditionalization.

There are two conditions which must be met in order or an updating rule to be a special case of some other updating rule. First, the domain of the less general rule rule — the special case — must be a proper subset of of the domain of the more general rule. In other words, any possible input to the less general rule will also be a possible input to the more general rule. Second, both rules must specify the same posterior credence function for every possible input to the less general rule (which by our first condition is also a possible input to the more general rule).

Strict Conditionalization is standardly considered to be a special case of Jeffrey Conditionalization. As we saw in section 3.1.1, Jeffrey Conditionalization is a rule of the form $(P_{old}(\cdot), \{< e_i, \omega_i >\}) \mapsto P_{new}(\cdot)$, i.e. the inputs to that rule consist of a prior credence function together with a weighted partition of the prior probability space. Strict Conditionalization is a procedure for updating on a propositional certainty. It has the form $(P_{old}(\cdot), < e, 1 >) \mapsto P_e(\cdot)$, where $e$ is the proposition and 1 represents the fact that credence in $e$ has been raised to the highest level, i.e. that $e$ certain.

In order to establish that Strict Conditionalization is a special case of Jeffrey Conditionalization we begin by showing that $< e, 1 >$ determines a weighted partition of the form $\{< e_i, \omega_i >\}$. Every probability space is partitioned by $\{e, \neg e\}$, and hence $\{< e, 1 >, < \neg e, 0 >\}$ is a partition with elements whose weights sum to 1. In other words, it's a possible input to Jeffrey Conditionalization. Jeffrey Conditionalizing upon that weighted partition means setting $P_{new}(\cdot)$ equal to $(P_{old}(\cdot \mid e) \cdot 1) + (P_{old}(\cdot \mid \neg e) \cdot 0) = P_{old}(\cdot \mid e)$, which is precisely what Strict Conditionalization recommends. Hence our two conditions are met — the domain of Strict Conditionalization is a proper subset of the domain of Jeffrey Conditionalization, and both rules recommend the same posterior credence function for each element common to both domains — so Strict Conditionalization is a special case of Jeffrey Conditionalization.

Gallow observes that Strict Conditionalization is also a special case of Holistic Conditionalization. Holistic Conditionalization is a rule of the form $(P_{old}(\cdot),$
$\{< e_i, t_i >\}) \mapsto P_{new}(\cdot)$: it defines a posterior credence function from a prior credence function together with a set of $e_i/\ t_i$ pairs. If for some reason the agent's background theories do not holistically affect the propositional evidence received from experience, the $t_i$ can be replaced with necessary proposition $\top$, so that $P_{new}(\cdot) = P_{old}(\cdot \mid e \& \top)) \cdot P_{old}(\top) = P_{old}(\cdot \mid e)$. The result is the same when a number of background theories determine exactly the same evidence proposition, i.e. when each of the $t_i$ is conjoined with the exact same evidence proposition $e$.

A casual reader of Gallow's paper could be forgiven for thinking that Jeffrey Conditionalization too is a special case of Holistic Conditionalization, but that's false; actually the relationship is the other way around. Recall that Holistic Conditionalization requires that the set of relevant background theories $\{t_i\}$ form a partition. That means that corresponding set of theory/ evidence conjunctions $\{e_i \& t_i\}$ also forms a partition.[21] Holistic Conditionalization also requires that the agent's posterior credence in each of the $e_i \& t_i$ be equal to their prior credence in $t_i$, thereby providing weight $\omega_i$ to each element of $\{< e_i \& t_i >\}$. In other words, the $(P_{old}(\cdot), \{e_i \& t_i\})$ input to Holistic Conditionalization determines a $(P_{old}(\cdot), \{< e_i \& t_i, \omega_i >\})$ input to Jeffrey Conditionalization. Hence the domain of Holistic Conditionalization is a subset of the domain of Jeffrey Conditionalization.

The point of this section is to demonstrate that Holistic Conditionalization is a special case of Jeffrey Conditionalization. I've now shown that each possible input to Holistic Conditionalization is also a possible input to Jeffrey Conditionalization. What's left is to show that each rule produces an identical output for every possible input to Holistic Conditionalization.

Recall that Holistic Conditionalization says that:

[21]Assuming that no theory generates propositional evidence that it regards as impossible. Dropping this assumption is disastrous for Holistic Conditionalization: since the posterior credence in each conjunction $e_i \& t_i$ is set equal to the prior credence of $t_i$, if $P_{old}(t_i) > 0$ it follows that $P_{new}(e_i \& t_i) > 0$ as well. Hence dropping our assumption would require that the agents assign a non-0 credence to an impossible proposition.

$$P_{new}(\cdot) = \sum_i P_{old}(\cdot \mid t_i \& e_i) \cdot P_{old}(t_i)$$

We've already seen (see footnote 15) that according to that rule, $P_{new}(t_i \& e_i) = P_{old}(t_i)$ for every $t_i/e_i$ pair, and so by substitution:

$$P_{new}(\cdot) = \sum_i P_{old}(\cdot \mid t_i \& e_i) \cdot P_{new}(t_i \& e_i)$$

This is precisely what Jeffrey Conditionalization would advise when updating upon a partition with elements of the form $t_i \& e_i$, which is the form shared by all inputs common to both rules. Hence Holistic Conditionalization is a special case of Jeffrey Conditionalization.[22]

### 3.4.1 Holistic Conditionalization is Rigid

In section 3.2 I argued that the rigidity of Jeffrey Conditionalization is perfectly compatible with perceptual learning that is vulnerable to undermining defeat. To remove any lingering doubt on that point I'll demonstrate that Holistic Conditionalization, which is undoubtedly consistent with perceptual learning that's vulnerable to undermining defeat, is also rigid.

Consider some arbitrarily selected background theory $t_1$ in partition $\{t_i\}$ and propositional evidence $e_1$ generated by $\mathcal{E}$ together with $t_1$.

We've already seen (footnotes 15, 16) that:

[22] Compare Huber [2014].

1. $P_{new}(t_1) = P_{old}(t_1 \mid t_1\&e_1) \cdot P_{old}(t_1) = P_{old}(t_1)$

2. $P_{new}(t_1\&e_1) = P_{old}(t_1\&e_1 \mid t_1\&e_1) \cdot P_{old}(t_1) = P_{old}(t_1)$

Since $t_1$ and $e_1$ were arbitrarily selected it follows that for any possible background theory $t_i$ and conjunction of theory and evidence $t_i\&e_i$:

3. $P_{new}(t_i) = P_{old}(t_i) = P_{new}(t_i\&e_i)$

Holistic Conditionalization says that:

4. $P_{new}(\cdot) = \sum_i P_{old}(\cdot \mid t_i\&e_i) \cdot P_{old}(t_i)$

By substitution, (3) and (4) allow us to restate Holistic Conditionalization as:

5. $P_{new}(\cdot) = \sum_i P_{old}(\cdot \mid t_i\&e_i) \cdot P_{new}(t_i\&e_i)$

Since $\{t_i\&e_i\}$ is a partition (assuming that every $t_i\&e_i$ is at least possible), the following is an instance of the total probability theorem:

6. $P_{new}(\cdot) = \sum_i P_{new}(\cdot \mid t_i\&e_i) \cdot P_{new}(t_i\&e_i)$

Finally, from (5) and (6) it follows that:

7. $P_{new}(\cdot \mid t_i\&e_i) = P_{old}(\cdot \mid t_i\&e_i)$

In other words, Holistic Conditionalization is rigid with respect to the elements of its input partition,[23] so there's no inconsistency between rigid updating rules and perceptual learning that's vulnerable to undermining defeat.

### 3.4.2 Holistic Conditionalization and Jeffrey Conditionalization, Again

I started out this paper noting that Jeffrey Conditionalization is not a complete theory of perceptual learning. As I've described things, the agent's posterior credences are the product of two distinct credence revisions: an exogenous revision on which the experience determines a weighted partition (i.e. $(P_{old}(\cdot), \mathcal{E}) \mapsto (P_{old}(\cdot), \{< e_i, \omega_i >\})$), and an endogenous revision on which that weighted partition together with the agent's prior credence function determine the posterior credences (i.e. $(P_{old}(\cdot), < \{B_i\}, \omega_i >) \mapsto P_{new}(\cdot)$). Since only the endogenous revision is governed by Jeffrey Conditionalization, that rule is incomplete as a theory of perceptual learning.

It should now be clear that Holistic Conditionalization too is an incomplete theory of perceptual learning, one that requires both endogenous and exogenous credence revisions while governing only the latter. Here things look slightly different, with exogenous credence revisions mapping experiences to

[23] Here's a second way to see the same point: the rigidity of Jeffrey conditionalization ensures that probabilities conditional on elements of the input partition never change via Conditionalization. We've now seen (section 3.4) that Holistic Conditionalization is a special case of Jeffrey Conditionalization, meaning that any shared input generates the same posterior credence function and hence the same posterior probabilities condition on elements of the input partition. In other words, Jeffrey Conditionalization is rigid, so every special case of that rule are rigid, so Holistic Conditionalization is rigid.

weighted partitions, where each partition element is a conjunction of a background theory and an evidence proposition ((i.e. $(P_{old}(\cdot), \mathcal{E}) \mapsto (P_{old}(\cdot), \{< e_i \& t_i, \omega_i >\})$), and endogenous revisions that determine the posterior credence function based on prior credences together with this partition.

Nonetheless, there is a case to be made that Holistic Conditionalization is *less* incomplete than Jeffrey Conditionalization because it requires *less* work to be done exogenously, and hence more of the agent's response to experience is governed by the rule. The inputs to the both rules contain three components: (i) the prior credence function, (ii) the elements of the partition, and (iii) the weights of those elements. For both rules, (i) is a pre-existing condition that does not need to be explained by a theory of perceptual learning, and (ii) is determined by the exogenous revision. But while Jeffrey Conditionalization also requires (iii) to be determined in addition to (i) and (ii), updating via Holistic Conditionalization does not. As we've seen, the elements of the Holistic Conditionalizers partitions are conjunctions of the form $e_i \& t_i$, and the weight of each of those elements is set equal to the prior credence in $t_i$. In other words, once (i) and (ii) are determined, (iii) is determined as well, and hence only (ii) needs to be determined exogenously. In contrast, Jeffrey Conditionalization determines the weights of the partition elements (i.e. the $\omega_i$) separately from the identity of those elements, and hence in order to updating using that rule both (ii) and (iii) must be determined exogenously.

Unfortunately, although Holistic Conditionalization seems to have more explanatory power than Jeffrey Conditionalization, some of those explanations are incorrect. Holistic Conditionalization implies that experience shouldn't change my credence in any of my background theories, but sometimes those credences should change in light of my experiences. Suppose that I have an experience as of a red hat. I'm sure that one of my two background theories is correct: either *the lighting is normal* or *the lighting is red*. If the lighting is normal then I receive as evidence *the hat is red*, and if the light is red then I don't receive any evidence at all;[24] hence my input partition is $\{< \textit{light normal,red hat} >, < \textit{light red}, \top >\}$. But since this experience is precisely what one would expect to have upon looking at a hat under a red light, one effect of my experience is that I ought to become more confident in that background theory, which by Holistic Conditionalization is impossible.

The lesson is this: because Holistic Conditionalization determines the weights of its partition elements in terms of the prior credence function, it enjoys a potential explanatory advantage over Jeffrey Conditionalization, on which those weights must be determined independently. But this advantage comes at a cost in terms of accuracy, as some of those endogenously determined weights are rationally inappropriate. Jeffrey Conditionalization places very few constraints upon the weights of the partition elements, and hence it does not face the same problem. Hence there's strong reason to prefer Jeffrey Conditionalization to Holistic Conditionalization.

[24]Below I consider a more realistic version of this case in which both theories also produce *it appears as though the hat is red* as evidence.

## 3.5 Holistic Conditionalization*

Holistic Conditionalization is unacceptable because it does not allow an agent's perceptual experience to affect their credence in a relevant background theory. One way to fix the problem is simply to incorporate a numerical multiplier the rule in order to allow confidence in background theories to vary:

**Holistic Conditionalization*:** $P_{new}(\cdot) = \sum_i P_{old}(\cdot \mid t_i \& e_i) \cdot P_{old}(t_i) \cdot \Delta_i$

Whereas Holistic Conditionalization ensured that $P_{new}(t_i) = P_{old}(t_i)$, on Holistic Conditionalization* $P_{new}(t_i) = P_{old}(t_i) \cdot \Delta_i$. Hence if $\Delta_i$ is any value greater than 1 then the credence in $t_i$ increases, and if $\Delta_i$ is less than 1 then the credence in $t_i$ decreases.

Gallow proposes an ingenious way to calculate the values of the $\Delta_i$ from the prior credence function that is broadly in line with Bayesian commitments to theory confirmation. Recall that on Holistic Conditionalization*, $\Delta_i$ is simply the value that is multiplied by $P_{old}(t_i)$ to determine $P_{new}(t_i)$. Understood this way, both Strict and Jeffrey Conditionalization too have $\Delta$-values equal to their *probability ratios*. A probability ratio represents the degree of confirmation that a theory receives from its successful prediction of the evidence by comparing the prior probability of the evidence conditional on the theory to the prior unconditional probability of that evidence. This quantity can then be multiplied by the prior probability of the theory to determine its posterior probability. When the evidence is a propositional certainty (as required by Strict Conditionalization), the probability ratio of theory $t$ to evidence $e$ is:

$$\Delta_t = \frac{P_{old}(e \mid t)}{P_{old}(e \mid \top)}$$

Informally, the function of the denominator is to establish a baseline probability for the evidence against which to compare the probability of that evidence conditional on the theory, as represented in the numerator. If the evidence is made more probable by the theory, then $\Delta_t > 1$, and since $P_{new}(t) = P_{old}(t) \cdot \Delta_t$, that means that $t$ is confirmed by the evidence. And since we've stipulated that the background theories form a partition, if one theory receives a credence boost by having a $\Delta$-value greater than 1, that boost must come at the expense of some other theory with a $\Delta$-value less than 1.

When the evidence is a weighted partition rather than a propositional certainty (as permitted by Jeffrey Conditionalization), the probability ratio of theory $t$ to evidence $\{e_j\}$ is:

$$\Delta_t = \sum\nolimits_j \frac{P_{old}(e_j \mid t)}{P_{old}(e_j \mid \top)} \cdot \omega_j$$

Here each element of the evidence partition establishes its own baseline against which the probability of that element conditional on the theory is measured. As before, if a given partition element is more probable conditional on $t$ than conditional on $\top$ (i.e. than the unconditional probability of that element) then the value of that fraction is greater than 1. The value of $\Delta_t$, then, is the sum of those fractions weighted by the posterior credences of each partition element, i.e. by the $\omega_j$. Finally, $\Delta_t$ will be greater than 1 (thus indicating that $t$ is confirmed by $\{e_j\}$) iff a sufficient number of partition elements are made sufficiently more probable relative to their individual baselines and then weighted sufficiently highly.

The $\Delta$-values of Holistic Conditionalization* are determined by considerations similar to those of Jeffrey Conditionalization: the relative success with which the agent predicts the evidence. However, for Holistic Conditionalization* the formal implementation of that approach is complicated by the fact that the background theories are allowed to disagree about what the evidence is: it might be the case that if $t$ is true then the evidence is $e$, but if $t'$ is true then the evidence is $e'$. This is important in the present context because the prior probability of the evidence is the baseline against which each theory's predictive success is measured, and hence without a shared body of evidence there's no shared unit of measurement.

This problem does not arise for Jeffrey Conditionalization, at least if we assume that $t$ and $t'$ do not appear in the input partition (either as elements of that partition, or as conjuncts in those elements). In that case there's no disagreement about the nature of the evidence, no temptation to relativize evidence propositions to background theories ("relative to $t$ the evidence is $e$, but relative to $t'$ the evidence is $e'$..."). Instead, 'the evidence' is just the evidence: input partition $\{e\}$.

Although Holistic Conditionalization* allows for lots of disagreement about whether or not some proposition is part of the evidence, there will also be lots of agreement. For example, suppose that my background theories are *the lighting is normal* and *the lighting is red* and then I have an experience as of a red hat. While my background theories might disagree about whether *the hat is red* is part of my evidence, presumably they will agree that *it appears as if the hat is red* is part of my evidence. Presumably it will also be the case that one theory does a much better job at predicting this shared evidence than the other: if the lighting is red, then any hat that I will see is going to appear to be red, where as normal lighting is consistent with the appearance of a hat of any color. Hence the shared evidence more strongly confirms *the lighting is red* than *the lighting is normal*. Informally, then, the proposal is that we calculate the $\Delta$-value for each theory using only shared evidence and ignoring disputed evidence.

Formally, we begin by establishing the shared baseline against which the predictive success of our background theories can be measured. Let $\{e_j\}$ be the set of propositions that are accepted as evidence by at least one theory, and let $\{t_i\}$ be a set of background theories (as before the background theories form a partition). For any $e_1 \in \{e_j\}$ there will be a non-empty subset of $\{t_i\}$ consisting of theories that regard $e_1$ as evidence. Let $\tau_1$ be the the set of background theories that regard $e_1$ as evidence. Since each $t_i \in \tau_1$ agrees that $e_1$ is an evidence proposition, we can use the probability of $e_1$ conditional on $\tau_1$[25] as a common baseline against which to measure the success of each $t_i$ in

[25]This is somewhat confusing: how can we define the probability of proposition $e_1$ conditional on set of propositions $\tau_1$? Answer: replace each instance $\tau_i$ with the disjunction

$\tau_1$ in predicting $e_1$, i.e. to measure the probability of $e_1$ conditional on each of the $t_i$. Finally, the $\Delta$-value for each background theory $t$ is determined by taking the weighted average of these measurements of $t$'s success:

$$\Delta_i \equiv_{df} \sum\nolimits_j \frac{\delta(e_j \mid t_i)}{P_{old}(e_j \mid \tau_j)} \cdot \frac{P_{old}(\tau_j)}{\sum_k P_{old}(\tau_k)}$$

where:[26]

$$\delta(e_j \mid t_i) \equiv_{df} \begin{cases} P_{old}(e_j \mid \tau_j) \text{ if } t_i \notin \tau_j \\ P_{old}(e_j \mid t_i) \text{ if } t_i \in \tau_j \end{cases}$$

I'll illustrate how this works by working through the example above and then describing the contribution of each part of the equation in determining the relevant $\Delta$-values. There are two relevant background theories — $t_N =$ *the lighting in normal* and $t_R =$ *the lighting is red* — each of which has a credence

of each $t_i \in \tau_i$. I've adopted Gallow's notation here, and apparently this is what he has in mind.

[26]If the numerator on the left represents the agent's credence in $e_j$ conditional on $t_i$, then why '$\delta(e_j \mid t_i)$' rather than '$P_{old}(e_j \mid t_i)$'? The point of the $\Delta$-values is to calculate the credence increase or decrease that theories receive its success in predicting each evidence proposition $e_j$ when that theory regards $e_j$ as evidence, and for that predictive success to be irrelevant when that theory does regard $e_j$ as evidence. Hence what's wanted is for:

$$\frac{\delta(e_j \mid t_1)}{P_{old}(e_j \mid \tau_j)} \cdot \frac{P_{old}(\tau_j)}{\sum_k P_{old}(\tau_k)} = \frac{P_{old}(\tau_j)}{\sum_k P_{old}(\tau_k)}$$

That requires that $\frac{\delta(e_j|t_1)}{P_{old}(e_j|\tau_j)} = 1$, which is exactly what we get when $\delta(e_j \mid t_1)$ is replaced with $P_{old}(e_j \mid \tau_j)$, in which case:

$$\frac{\delta(e_j \mid t_1)}{P_{old}(e_j \mid \tau_j)} \cdot \frac{P_{old}(\tau_j)}{\sum_k P_{old}(\tau_k)} = \frac{P_{old}(e_j \mid \tau_j)}{P_{old}(e_j \mid \tau_j)} \cdot \frac{P_{old}(\tau_j)}{\sum_k P_{old}(\tau_k)} = 1 \cdot \frac{P_{old}(\tau_j)}{\sum_k P_{old}(\tau_k)}$$

of $^1/_2$. Upon having an experience as of a red hat, both theories agree that $e_{Ar}$ = *it appears as though the hat is red* is evidence, but only $t_N$ regards $e_r$ = *the hat is red* as evidence. For each evidence proposition $e_i$ there is a set $\tau_i$ of background theories that regard that proposition as evidence; in this case the sets are $\tau_{Ar} = \{t_R, t_N\}$ and $\tau_r = \{t_N\}$. The credence in each of those sets is equal to the credence in the disjunction of each of its (pairwise inconsistent) members, so $P_{old}(\tau_{Ar}) = P_{old}(t_R) + P_{old}(t_N) = 1$ and $P_{old}(\tau_r) = P_{old}(t_N) = {}^1/_2$. This in turn allows us to calculate $\sum_k P_{old}(\tau_k) = P_{old}(\tau_{Ar}) + P_{old}(\tau_r) = {}^3/_2$.

Before my experience as of a red hat, I think that it is fairly unlikely that the hat is red, and also that its redness is independent of facts about the current lighting conditions; I think that $P_{old}(e_r) = P_{old}(e_r \mid t_N) = P_{old}(e_r \mid t_R) = {}^1/_5$. However, I think it far more likely that it will appear as if the hat is red given red lighting than the hat appearing red given normal lighting, so although $P_{old}(e_{Ar} \mid t_N) = {}^1/_5$, $P_{old}(e_{Ar} \mid t_R) = {}^2/_5$.[27]

This allows us to calculate the remaining values required to determine $\Delta_{t_R}$ and $\Delta_{t_N}$. $P_{old}(e_{Ar} \mid \tau_{Ar})$ is the credence of evidence $e_{Ar}$ conditional on the disjunction of each $t_i \in \tau_{Ar}$, i.e. conditional on $t_R \vee t_N$. $e_{Ar}$ occupies $^2/_5$ of $\tau_{t_R}$'s half of the probability space and $^1/_5$ of $\tau_{t_N}$'s half, so $P_{old}(e_{Ar} \mid \tau_{Ar}) = {}^3/_{10}$. Since $t_N$ is the sole member of $\tau_r$, $P_{old}(e_r \mid \tau_r) = P_{old}(e_r \mid t_R) = {}^1/_5$.

We're now in a position to calculate $\Delta_{t_N}$ and $\Delta_{t_R}$. By definition:

[27]While the redness of the lighting would make just about everything look red, it would not make things look like hats, so my confidence that something will look like a red hat is still relatively low.

$$\Delta_{t_N} \equiv_{df} \sum_j \frac{\delta(e_j \mid t_N)}{P_{old}(e_j \mid \tau_j)} \cdot \frac{P_{old}(\tau_j)}{\sum_k P_{old}(\tau_k)}$$

Since $e_r$ and $e_{Ar}$ are the only two propositions regarded as evidence by either theory, and since $t_N$ regards both of them as evidence, this becomes:

$$\begin{aligned} &\left(\frac{P_{old}(e_{Ar} \mid t_N)}{P_{old}(e_{Ar} \mid \tau_{Ar})} \cdot \frac{P_{old}(\tau_{Ar})}{\sum_k P_{old}(\tau_k)}\right) + \left(\frac{P_{old}(e_r \mid t_N)}{P_{old}(e_r \mid \tau_r)} \cdot \frac{P_{old}(\tau_r)}{\sum_k P_{old}(\tau_k)}\right) \\ &= \left(\frac{1/5}{3/10} \cdot \frac{1}{3/2}\right) + \left(\frac{1/5}{1/5} \cdot \frac{1/2}{3/2}\right) \\ &= 7/9 \end{aligned}$$

Similarly,

$$\Delta_{t_R} \equiv_{df} \sum_j \frac{\delta(e_j \mid t_R)}{P_{old}(e_j \mid \tau_j)} \cdot \frac{P_{old}(\tau_j)}{\sum_k P_{old}(\tau_k)}$$

Again $e_r$ and $e_{Ar}$ are the only two propositions regarded as evidence by either theory, but since $t_R$ regards only $e_{Ar}$ as evidence, this becomes:

$$\begin{aligned} &\left(\frac{P_{old}(e_{Ar} \mid t_R)}{P_{old}(e_{Ar} \mid \tau_{Ar})} \cdot \frac{P_{old}(\tau_{Ar})}{\sum_k P_{old}(\tau_k)}\right) + \left(\frac{P_{old}(e_r \mid \tau_r)}{P_{old}(e_r \mid \tau_r)} \cdot \frac{P_{old}(\tau_r)}{\sum_k P_{old}(\tau_k)}\right) \\ &= \left(\frac{2/5}{3/10} \cdot \frac{1}{3/2}\right) + \left(\frac{1/5}{1/5} \cdot \frac{1/2}{3/2}\right) \\ &= 11/9 \end{aligned}$$

Now for an informal explanation of what's going on with each part of the equation. Background theories are required to form a partition, and hence any increase in credence for one theory must come at the cost of a decrease in credence for some other theory. In particular, when a theory increases in credence due to its successfully prediction of an evidence proposition, that increase comes at the cost of a decrease in credence for other theories. The overall effect a theory's predictive success upon the credence in that theory (i.e. its $\Delta$-value) is a function of the theory's success in predicting each of the evidence propositions, and hence the things to be explained are (i) how a theory's success in predicting each evidence proposition is to be measured, and (ii) how these measures a theory's success in predicting each individual evidence propositions is to be aggregated into an overall measure of its overall success in predicting the evidence.

To see how this works with Holistic Conditionalization*, let's focus on a particular summand from our calculation of $\Delta_{t_R}$:

$$\frac{P_{old}(e_{Ar} \mid t_R)}{P_{old}(e_{Ar} \mid \tau_{Ar})} \cdot \frac{P_{old}(\tau_{Ar})}{\sum_k P_{old}(\tau_k)}$$

The fraction on the left measures $t_R$'s predictive success with respect to a single evidence proposition: $e_{Ar}$. The numerator $P_{old}(e_{Ar} \mid t_R)$ represents the confidence with which $t_R$ predictions $e_{Ar}$, and the denominator provides a baseline against which that confidence is measured. Importantly, that baseline of comparison need not be the prior probability of $e_{Ar}$ conditional on the set of *all* of the background theories. Rather, it's $e_{Ar}$ conditional on the set consisting only in the other background theories that regard $e_{Ar}$ as evidence.

In the example above, both theories regard $e_{Ar}$ as evidence, and so it happens that the denominator $P_{old}(e_{Ar} \mid \tau_{Ar}) = P_{old}(e_{Ar}) = {}^{3}\!/_{10}$. This baseline value is lower than $P_{old}(e_{Ar} \mid t_R)$, i.e. $t_R$ does a better-than-baseline job of predicting the evidence, and hence the value of the fraction on the left is greater than 1.

While the fraction on the left determines how the portion of the state space occupied by $\tau_{Ar}$ will be redistributed among its constituent background theories, the fraction on the right determines the size of the probability space to be redistributed. This is simply the credence in $\tau_{Ar}$ divided by the sum of the $\tau_i$, which in or example include $\tau_{Ar}$ and $\tau_r$.[28] When the two fractions are multiplied together we get a measure of $t_N$'s success in predicting $e_{Ar}$ weighted by the joint prior probability of all of the theories regarding $e_{Ar}$ as evidence. Finally, taking the sum of these values for each evidence proposition generates the value of $\Delta_{t_N}$.

### 3.5.1 Holistic Conditionalization* and Immediate Perceptual Justification

The relationship between Jeffrey Conditionalization and Holistic Conditionalization* is much like the relationship between Jeffrey Conditionalization and Holistic Conditionalization. Jeffrey Conditionalization is a general-

[28]Note that if the $\tau_i$ formed a partition then the denominator $\sum_k P_{old}(\tau_k)$ would always be equal to 1, and hence the fraction on the right could always be replaced by the relevant $\tau_i$. But the $\tau_i$ don't form a partition: theories can regard multiple propositions as evidence and hence a single theory can be a member of multiple $\tau_i$. This is the case in our example with $t_N$, which regards both $e_r$ and $e_{Ar}$ as evidence and hence is a member of both $\tau_r$ and $\tau_{Ar}$.

ization of Holistic Conditionalization: any input to the latter is of the form $(P_{old}(\cdot), \{e_i\&t_i\})$,[29] which determines an $(P_{old}(\cdot), \{< e_i\&t_i, \omega_i >\})$ input to Jeffrey Conditionalization, and each rule determines the same posterior credence function given that input. Evaluated as rules for responding to experience, Holistic Conditionalization* has an explanatory advantage over Jeffrey Conditionalization, since more of the work of determining a posterior credence function is being done endogenously. The problem with Holistic Conditionalization was that its explanatory power came at the expense of accuracy, as it prohibited revised credences in the background theories.

Holistic Conditionalization* shares Holistic Conditionalization's advantage over Jeffrey Conditionalization. The weights of its partition elements are set equal to the product of two values that are themselves determined by the prior credence function: $P_{old}(t_i)$ and $\Delta_i$. But because Holistic Conditionalization* allows credences in background theories to change, it is not inaccurate in precisely the same way as Holistic Conditionalization. Nonetheless, there's reason to worry that Holistic Conditionalization* is inaccurate in other ways. Any apparent increase in explanatory power brings with it an increased chance of getting something wrong. Holistic Conditionalization* has an explanatory advantage over Jeffrey Conditionalization because it determines the weights of the partition elements on the basis of the prior credence function, where as Jeffrey Conditionalization offers no account at all about the determinatnio of

[29]Here I've dropped the '$\omega_i$' in my specification of the output of Holistic Conditionalization's exogenous revisions, as those values are determined by what I've left in $(P_{old}(\cdot)$ and $\{e_i\&t_i\})$.

these weights. The potential problem for Holistic Conditionalization* is that the weights that it specifies force agents to adopt inappropriate credences, just as Holistic Conditionalization did.

Consider again the case in which I'm not sure whether *the lighting is normal* or *the lighting is red* and then I have an experience as of a red hat. According to Holistic Conditionalization, my attitudes towards my various background beliefs partially determine what evidence I receive, but the evidence that I receive does not influence my attitudes towards those background theories; my credence in them does not change across the learning episode. Holistic Conditionalization* relaxes this constraint somewhat, allowing my attitudes towards background beliefs to change in light of new evidence, but with a very important caveat: the evidence that affects a particular background theory is limited to what that theory regards as evidence. For example, according to background theory *the lighting is red* my experience as of the red hat does not generate propositional evidence *the hat is red*, and hence my credence in that theory is completely unaffected by the fact that some other theory regards that proposition as evidence.

Whether we welcome this aspect of Holistic Conditionalization* depends on our other commitments in the epistemology of perception. Non-skeptics about perceptual justification will agree that it's at least possible that I could become highly confident in *the hat is red* on the basis of my experience. (Non-skeptical) 'Dogmatists' about perception will go further and claim that this high degree of confidence is immediate, in the sense that it's the experience alone that makes me so-justified, rather than the experience together with antecedent justification for beliefs about the lighting, or about the reliability of my perceptual faculties, or anything else.[30] In this section I argue that Holistic Conditionalization* combines awkwardly with the possibility of obtaining evidence that is both immediate and vulnerable to undermining defeat, and hence combines awkwardly with non-skeptical Dogmatism about perception.

Suppose that I have a visual experience of a red hat and on that basis I increase my credence in *the hat is red* from $1/5$ to $9/10$ using Holistic Conditionalization*. In order to avoid Weisberg's puzzle, that proposition must be one of the $e_i$ that partially constitute input partition $\{t_i \& e_i\}$; otherwise it's impossible to introduce a negative correlation between *the hat is red* and any of its undermining defeaters. In other words, *the hat is red* must be among the propositions whose credence is revised exogenously. But here's the problem: when I update via Holistic Conditionalization*, my posterior credence in *the hat is red* (and in every other exogenously revised proposition) will depend upon my prior credences in the background theories that predict that evidence in a way that is plausibly inconsistent with the immediacy of that credence boost. This phenomenon will generalize to every other instance of underminable perceptual learning, meaning that Holistic Conditionalization* is arguably inconsistent with perceptual learning that is both immediate and underminable.

[30] For more on Dogmatism see Pryor [2000], [2005], [2013].

I'll illustrate with an example. Suppose that I'm sure that either *the lighting is normal* (=$t_N$) or *the lighting is red* (=$t_R$) and that my credence in each is $1/5$. If the lighting is normal then the evidence that my experience generates consists in two propositions: $e_r$ = *the hat is red* and $e_{Ar}$ = *it appears as though the hat is red*, but if the lighting is red then my evidence is only $e_{Ar}$. By Holistic Conditionalization* it follows that: my posterior credence in $e_r$ is equal to:

$$P_{new}(e_r) = [P_{old}(e_r \mid t_N \& (e_r \& e_{Ar})) \cdot P_{old}(t_N) \cdot \Delta_{t_N}]$$
$$+ [P_{old}(e_r \mid t_R \& e_{Ar}) \cdot P_{old}(t_R) \cdot \Delta_{t_R}]$$

By hypothesis, one result of my experience as of the red hat is to dramatically increase my confidence in $e_r$, so that increase must be located somewhere in our equation. We would not normally expect a correlation between something appearing to be red when illuminated by a red light and that thing actually being red, so it's at least possible that $P_{old}(e_r \mid t_R \& e_{Ar}) = P_{old}(e_r)$. Supposing this to be just such a case, this together with my stipulated prior credences in $t_N, t_R$, and $e_r$, the above simplifies to:

$$P_{new}(e_r) = [1/2 \cdot \Delta_{t_N}] + [1/10 \cdot \Delta_{t_R}]$$

In describing the case I stipulated that $P_{new}(e_r) = 9/10$. Clearly this will require relatively large values for $\Delta_{t_N}$ and $\Delta_{t_R}$. But there's a complication:

when a theory's $\Delta$-value is greater than 1, that theory receives a credence boost at the expense of another theory. Since $t_N$ and $t_R$ form a partition, it follows that in order for one to increase in credence the other must decrease: $\Delta_{t_N} > 1$ iff $\Delta_{t_R} < 1$. Since $1/2$ multiplier for $\Delta_{t_N}$ is larger than the $1/10$ multiplier for $\Delta_{t_R}$, achieving $P_{new}(e_r) = 9/10$ requires that $\Delta_{t_N}$ increase dramatically at the expense of $\Delta_{t_R}$. Unfortunately, given the way that $\Delta$-values are defined, that's impossible.

Informally, the problem is that $t_N$ receives a credence boost for predicting evidence more successfully than $t_R$ only when both theories predict that same evidence. But the only evidence that both theories predict is $e_{Ar}$, that the hat appears red, and in most plausible cases $t_R$ actually does a better job of predicting $e_{Ar}$ than $t_N$; after all, I'm more likely to see red hats when the lighting is red than when the lighting is normal. That means that the episode of learning will actually increase my credence in $t_R$ at the expense of $t_N$, precisely the opposite of what's needed.

There are a number of ways to patch things up, but each is problematic for the Dogmatist. One way to patch things up is to drop the supposition that $t_R$ and $e_r$ are independent and insist that they are strongly positively correlated. This would improve the situation by increasing the multiplier for $\Delta_{t_R}$; increase that value enough and it no longer matters that $\Delta_{t_N}$ is somewhat higher than $\Delta_{t_R}$. There are two problems with this approach: first, it just false that there's a strong correlation between something's looking red under red light and it actually being red, so this approach is ad hoc. Second, one of the desired outcomes of the case is that, after I've experienced the redness of the hat and updated accordingly, $t_R$ should function as an undermining defeater for $e_r$. But that's only possible if the correlation between $t_R$ and $e_r$ is weaker than the correlation between $t_R$ and $\neg e_r$. Hence on this approach there's a conflict between what's required in order to obtain a high posterior credence in $e_r$ — a strong correlation between $t_R$ and $e_r$ — and what's required in order for $t_R$ to function as an undercutting defeater for $e_r$: a weak correlation between those propositions.

A second approach is to constrain the circumstances under which a red-hat experience licenses a high credence in $e_r$. Above I stipulated that my credence in both $t_N$ and $t_R$ was $1/2$. If instead I had set things up so that $P_{old}(t_N) = 19/20$ while $P_{old}(t_R) = 1/20$ and kept everything else was the same, then even a $\Delta_{t_N}$-value slightly less than 1 would still permit a posterior credence in $e_r$ to be $9/10$.

While this approach is not completely implausible, it is arguably inconsistent with the *immediacy* of my high credence in $e_r$. If my high posterior credence in $e_r$ depends upon my having a high prior credence in $t_N$, and hence in my having a high prior credence in $\neg t_R$, then it's plausible that my attitude toward $\neg t_R$ is part of what makes it rational for me to have a high confidence in $e_r$.[31] But this is precisely what Dogmatism and other theories of immediate

[31]This move can be resisted, as the sort of dependence relevant to the immediacy of justification is arguably a special case the broader phenomenon of modal dependence. For discussion see Kung [2010] and Zardini [2014].

justification mean to rule out: the necessity of antecedently ruling out potential undermining defeaters for perceptually supported propositions before that learning can take place. Hence Dogmatism and Holistic Conditionalization* are inconsistent.[32]

## 3.6 Conclusion

From the perspective of the Dogmatist, Holistic Conditionalization* is inadequate for the same reason Holistic Conditionalization and Strict Conditionalization are inadequate. Each rule is a special case of Jeffrey Conditionalization, differing in that it imposes additional constraints upon the possible inputs to the respective rule. And each rule is ultimately problematic because these additional constraints prove to be too restrictive to model instances of perceptual learning.

Strict Conditionalization restricts its inputs to propositional certainties. But in the Bayesian framework propositional certainties are indefeasible, and hence the inputs cannot be both immediate and vulnerable to undermining defeat. Holistic Conditionalization allows its propositional inputs to be defeasible and uncertain, but in disallowing experience to affect an agent's credences in their background theories it proves overly restrictive.

Finally, Holistic Conditionalization* allows inputs that are both defea-

[32] There's a strong resemblance between my argument and the argument against the consistency of Dogmatism with Strict Conditionalization advanced by White [2006] and others. See Miller [forthcoming] for more detailed discussion.

sible and uncertain, and also allows background theories to be confirmed or disconfirmed based on their successful prediction of evidence received. It also has a potential explanatory advantage over Jeffrey Conditionalization: while both rules take as inputs a prior credence function together with a weighted partition, Holistic Conditionalization specifies how the weights of the partition elements are determined by the prior credence function, while Jeffrey Conditionalization requires that those weights be specified independently. Unfortunately, the restriction that provides this explanatory advantage is inconsistent with the immediacy of perceptual justification.

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